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J. A. BERLY'S

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THE INTENSITY OF THE RADIATION OF GAS UNDER THE INFLUENCE OF ELECTRICAL DISCHARGE.

THE interesting phenomena which accompany electrical discharges through rarefied gases, although still for the most part unexplained, have of late been repeatedly investigated both in the optical and in the electrical direction. The quantitative relation between the optical and the electrical phenomena has, however, been but little studied. Now, it is only by a more perfect knowledge of this relationship that we may hope to understand and explain the origin and the nature of the radiation which is observed in Geissler's tubes, as also the part which electricity plays in those remarkable phenomena.

Researches have been made by E. Wiedemann, and more recently by Staub in this direction; but, however valuable their results may have been, they do not give a direct answer to the question of the radiation of the gas under the action of the electric discharge. Hence we are glad to notice that K. Angström has approached the subject, and has been using the bolometer in the endeavour to determine the radiation of different gases under the action of the electrical current; to express the intensity of this radiation in absolute measure, and to endeavour, then, to determine the relation of the radiation to the causes which produce it.

After a year's work, the preliminary trial experiments are completed, and some rather important results have been obtained which form the substance of a communication to the April number of the *Philosophical Magazine*, where our readers may find details of the way the experiments were conducted.

The researches extended to oxygen and hydrogen liberated by electrolysis of pure water acidulated by phosphoric acid, to nitrogen produced by leading pure air freed from carbonic acid over heated copper, and to carbonic acid produced by heating sulphuric acid mixed with oxalic acid, and purified by passing through a solution of potash.

The most important results of this investigation may be summarised as follows:—

For a given pressure, the radiation of positive light is proportional to the intensity of the principal current. It is true that on using very powerful currents small divergencies are observed, but in this case they are always accompanied by a permanent alteration of the gas, so that the same radiation is not met with again for less strong currents.

If the electric current is kept constant, and the pressure is varied, it appears that the intensity of total radiation scarcely varies between the limits of 0·1 to 1·5 mm., but it increases a little at higher pressures. At pressures exceeding 1·5 mm. the character of the discharge seems to be modified, after which the radiation increases considerably with the

pressure after having passed, at any rate in certain cases, through a minimum.

For the same gas under the same pressures the composition of the radiation is constant, and does not depend on the intensity of the electrical current.

When the density of the gas changes, the composition of the radiation changes also, in so far that the ratio of the intensity of radiation of the shorter wave-lengths to that of the total radiation decreases with increase of pressure. This ratio varies, *e.g.*, between the pressures 0·1—1·6 mm., for carbonic acid from 46 to 15 per cent., and for nitrogen from 94 to 60 per cent.

The ratio between the luminous and total radiation rises to considerable values for very low pressures, values far greater than those of our ordinary luminous sources. It does not, however, always attain such high value in the electrical discharge in rarefied gases. At pressures of 5—10 mm. it is rather small.

The intensity of the total radiation varies greatly for different gases. It is not in a simple ratio with the molecular weight of the substance, or with the difference of potential in the layer of radiating gas. It does not appear to depend essentially on the absorption of the gas at the ordinary pressures and temperatures, either as regards its intensity, or in reference to its composition.

In the case of low pressures the following explanation is given by Angström :—When the rarefied gas becomes a conductor of an electrical current, it is the molecules principally which serve to transport electricity, that is to say, the active molecules which radiate. The number of these molecules is proportional to the intensity of the current, and varies but little with the variations of pressure as long as the discharge retains its character. This radiation is of an irregular character, according to von Helmholtz, or it belongs to the class of phenomena termed by E. Wiedemann *phenomena of luminescence*, in this sense, that the composition of the radiation does not correspond with the temperature of the gas. The radiation may be of extreme intensity in the groups of short wave-lengths.

When the pressure increases, and with it the number of inactive molecules, the irregular radiation of the active molecules may more easily be transmitted to the former. The number of radiating molecules increases therefore, and consequently also the radiation of the gas, but it changes in character in this sense, that the radiation of the groups of shorter wave-lengths diminishes.

The City and South London Railway.

IT is about a year and a half ago since the City and South London Railway first began to carry passengers, but in this short period the working of the concern has been marred by derelictions of duty which have resulted in fatalities. It is only a few months ago since we commented on the death of a passenger, who was killed while attempting to enter the lift when in motion ; we then pointed out that had the man in charge been observant of his duties, such an accident could not have occurred. However, that calamity has not long served as a warning against the infraction of rules, for last week the guard of a train invited passengers to view the engine going at full speed, with the result that a passenger fell between the engine and the carriages and was killed. Without expatiating on the terrible nature of the accident, we cannot refrain from protesting against the extraordinary laxity which appears to be at times rampant on the electric railway. To open the door near the engine is considered by the manager and engineer to be a most dangerous practice, and yet the guard admitted at the inquest that he had often done so. While allowing a good deal for the curiosity of the public, we do certainly think a better supervision of the working of the line is needed. Nor do we think that too much blame ought to be thrown on the guard, for the management seems to have been too ready to treat the railway more as a show than as a means of conveyance, and when the directors ask the public to view the generating station at Stockwell on the payment of 6d., it is perhaps not surprising to find the officials imbued with a similar desire. When more attention is paid to the real business of the railway, then the chances of accident will be reduced to a minimum.

The Government and the Telephones.

"THE massacre of the Innocents" is the term which has been applied to the wholesale abandonment of Government measures at the end of a session. The Telegraph Bill, which contains the telephone proposals of the Government, is apparently a measure not sufficiently innocent to be abandoned. On the contrary, in his statement to the House on Monday, Mr. Balfour said that it was before a committee, and he confidently hoped it would be passed. We, as confidently, hope that it will not be passed. We do not know of what members the committee is composed, but it may be safely asserted that they must at the present moment be so largely occupied with considerations relating to their constituencies, as to be prevented giving to the Telegraph Bill the attention which is unquestionably necessary, in order that its defects may be eradicated. The measure is one of the first importance, and should not be pressed through hurriedly at the fag end of a session. If it is dropped now there should be no difficulty in replacing it by a better measure next session.

Azores Cable.

WE notice in a telegram to the daily press that on the 11th inst. a contract was signed in Lisbon between the Portuguese Government and the French Telephone Company, for the laying of submarine telegraph cables between Lisbon and the Western Islands or Azores. This seems to be the result of the struggle between the Telegraph Construction and Maintenance Company with its allies the Eastern and Brazilian Cable Companies, and the new constructing works which have lately been established in Calais by the French Telephone Company. The French company has carried the day, and this success and that attending the laying of their group of cables in the West Indies and to Brazil, must prove to English manufacturers that they find themselves to-day face to face with a most serious competition in a line of business which has hitherto been an English monopoly. To prove the wisdom of this new venture time is necessary, as these new cables form only a portion of the designs of the company. These are to connect France with Lisbon direct and to place the Azores in telegraphic communication with the American continent, and with the French system of cables now laid and working in the West Indies and to Brazil. One thing appears certain, and that is, that the French combination command a considerable amount of money, or with their present investments in the West Indian lines they would not undertake fresh responsibilities unless they were sure of their financial strength. That extensions from the Azores are intended their Portuguese contract shows, even if the poverty of the Western Islands, from a telegraph point of view, did not lead one to believe that there is no possibility of terminating in such a locality lines which have no Government subsidy.

Transformers.

IN the *Electrical World* we note the commencement of a series of articles by M. Dolivo-Dobrowolsky on "Transformer Efficiencies." It is rather amusing to note that he claims as his own the idea that the magnetism always attains the necessary value to account for the impressed E.M.F. Surely this is the way which all those who have considered the matter with any care must have arrived at for calculating the exciting current, and cannot be claimed by M. Dobrowolsky as his "fundamental law." We hope to further criticise the articles when they are complete.

The Magnetic Exploring Coil.

MR. W. M. STING, in an article in the *Electrical Engineer*, describes some interesting results which he has obtained with a "Magnetic Exploring Coil," used for the purpose of analysing the cause of the humming sound which is so marked in some dynamos. The apparatus employed was an induction coil, with the usual bundle of iron wires for the core, and the coil connected to a Bell telephone receiver. When the coil was brought near the pole of a dynamo, which, owing to an insufficient amount of iron in its frame, had always shown a large amount of magnetic leakage, a loud musical note was heard, which corresponded in pitch to the annoying humming sound usually emitted by the machine. This entirely agreed with the usual behaviour of the machine. When the commutator bars became worn and slightly rounded, this humming was most pronounced. A part of the noise was then doubtless due to the vibration of the brushes themselves, but from the fact that the tone heard in the receiver has been more marked at such times, one is almost forced to the conclusion that the humming is in the iron of the machine, since in this case the variations in current strength would be very marked on the passage of the rounded segments under the brushes. When the coil was held at the air gap in the field, the note was painfully loud, and the intensity of the sound increased perceptibly when it was brought near some bolt heads on the poles, or the edges of the pole-pieces themselves, the best effect being obtained in each case, as a matter of course, when the axis of the coil lay in the lines of force. When the series coil of this compound-wound dynamo was tested, the same tone was distinctly heard. A Thomson-Houston continuous current dynamo of the "motor type" was also tested, and very little external leakage could be detected. A local short-circuiting of lines of force was, however, noted in the lower portions of both shunt coils. The arc dynamo of the same company yielded some very interesting results. The nuts on the ends of the yoke bars produce a louder tone than any other portion of the frame, excepting the sharp edges at its ends. There appeared, also, to be a well-defined line of leakage extending from the lower portion of the negative end of the frame to the upper part of the positive end. If the coil is moved around the commutator, the position for maximum efficiency for the brushes is clearly indicated. It is also shown that there is a deformation of the external field surrounding the winding, corresponding to the forward shifting of the magnetic axis by the rotation of the armature.

Atmospheric Electricity at High Altitudes.

NOT the least interesting features of Mr. Whymper's new book, "Travels among the Great Andes of the Equator," are his stray allusions to the extraordinary phenomena of atmospheric electricity which he and his companions witnessed during their arduous mountain climbing. This book, which has taken so many years in preparation, is undoubtedly the "book of the season"; although it will probably prove too heavy for the general reader in search of exciting adventure. Speaking of the ascent of Cotopaxi, Mr. Whymper says, "Storms of hail were frequent . . . . stray flashes of lightning occurred in uncomfortable if not in dangerous proximity—blazing out at unexpected times, and conveying the impression that the atmosphere was saturated with electricity." Similar experience attended the scaling of Sincholagua. "Half-inch hailstones bounded and ricochetted in all directions, and smote the rocks with such fury that they dislodged or actually broke fragments from the higher ledges. . . . . Snow began to fall, at first mixed with the hail, and afterwards in large flakes, thickly. The hail ceased and was succeeded by lightning. . . . . The summit was invisible, and our *arrête*, rising at an increasing angle, disappeared in the thunder clouds. Hitherto the flashes had only glanced occasionally through the murky air, each followed by a single bang, which is all one hears when close to the point of discharge. Around the peak they blazed away without intermission, several often occurring in a single instant. The whole air seemed to be saturated with electricity, and the thunder kept up an almost continuous roar." The descent was performed "with the lightning blazing all around as far as the end of the summit ridge; then it ceased." One cannot help regretting that, under such remarkable conditions as these, the object of the expedition was not to make observations upon atmospheric electricity, but to ascertain the effect on man of low atmospheric pressures, and of exactly ascertaining the altitude he is able to reach. There is one amusing custom prevalent amongst the inhabitants of Quito, to which Mr. Whymper does full justice. The people take off their hats at flashes of lightning, no matter whether rain is falling; and when the streets are busy and lightning is abundant, a grotesque effect is produced by these salutations, which seem to be regarded as a duty by well-behaved persons, and are performed as punctiliously as the homage which is paid in these parts to religious processions.

Note on the Laws of Electrolysis.

A PAPER by Mons. A. Chassy was presented by Mons. Lippmann at a recent meeting of the Paris Academy of Science which dealt with certain points in the laws of electrolysis. When a substance of the complex formula $M_p R_q$ is electrolysed, M designating an electro-positive radical and R an electro-negative radical then, according to Becquerel, there is disengaged 1 equivalent of R and $\frac{p}{q}$ equivalent of M, whilst in the same circuit is evolved 1 equivalent of hydrogen from a water voltameter. But according to G. Wiedemann and several other physicists, this law presents a number of exceptions, for, in the case of several substances, there is disengaged $\frac{q}{p}$ equivalent of the radical R and 1 equivalent of the other radical under similar conditions. Mons. Chassy, in his paper, proposes to replace this law with its exception by a single law which shall satisfy every case. In the formula $M_p R_q$ he replaces M_p by a certain quantity of hydrogen H_p, calling M_p and H_p "corresponding quantities," *e.g.*, in $Fe_2 Cl_3$ he substitutes for Fe_2 the term H_3, so that in this case $\frac{2}{3}$rds Fe is the quantity corresponding to H, whilst in Fe Cl, Fe is replaced by H, and is the quantity corresponding to H. In order to obtain these "corresponding quantities," it is not necessary to know the formula which corresponds to the electrolytic molecule, and their determination is independent of the theory. Really the expression "equivalent quantity" would be preferable were it not employed already in another sense. The new law proposed by Mons. Chassy, to cover all cases, reads as follows:—*When any substance whatever is electrolysed there is always disengaged one equivalent of hydrogen or the corresponding quantity of the electro-positive radical.* He considers that this statement covers all known facts and agrees with the theories of Becquerel, Wiedemann and Faraday, besides providing for the exceptions which these physicists found difficult to deal with, and applying to a certain number of substances which have not yet been properly studied on account of the complex secondary reactions which take place during their electrolysis. Mons. Chassy gives several illustrations of his method of applying his new law, which may be found in the *Comptes Rendus*, Vol. cxiv., No. 18, pp. 998—1,000.

THE CALCULATION OF THE SECTION OF FEEDERS SUPPLYING CENTRES WITH CONSTANT POTENTIAL.

IT sometimes happens that when studying an electrical distribution, we have to feed a centre with constant potential by means of a feeder starting from the distribution board. From this centre start conductors supplying similar receivers, these conductors being as nearly as possible the same length (in order that the difference of tension at the terminals of the receivers may be the same for all).

In this case, if the loss of tension between the board of the principal station and the receivers is given, it is interesting to find out what are the relative sections to be given to the feeder and the secondary conductors, in order that the total weight of copper to be used may be at the minimum (the example we are going to quote, writes M. Loppe in *L'Industrie Electrique*, shows that the saving may be considerable). Let

L be the total length of the feeder ;

l the total length of each of the n secondary conductors ;

i the intensity of the current in one of the receivers in ampères ;

e the loss of charge allowed in volts ;

e' the loss of charge in the feeder ;

e'' the loss of charge in the secondary conductors.

We get

$$e' + e'' = e.$$

The current circulating in the feeder will have at the maximum an intensity of $n\,i$ ampères.

The weight, M, of the copper of the feeder will be

$$M = \frac{A\,L^2\,n\,i}{e'},$$

A being a constant.

The weight of copper to be used for the secondary branches will be

$$M' = n\,.\,\frac{A\,l^2\,i}{e''}.$$

We must, therefore, reduce to a minimum the quantity

$$M + M' = n\,.\,A\,i\left(\frac{L^2}{e'} + \frac{l^2}{e''}\right),$$

or, rather

$$\frac{L^2}{e - e''} + \frac{l^2}{e''}$$

for we get

$$e' = e - e''.$$

Taking the derived circuit and making it equal to 0, we get

$$\frac{L^2}{(e - e'')^2} - \frac{l^2}{e''^2} = 0$$

The second derived branch—

$$\frac{2\,(e - e'')\,L^2}{(e - e'')^4} + \frac{2\,e''\,l^2}{e''^4}$$

is evidently positive, since e is greater than e'' ; we have therefore to do with a minimum. The equation thus becomes

$$e''^2\,(L^2 - l^2) + 2\,e''\,e\,l^2 - l^2\,e^2 = 0,$$

whence we get

$$e'' = \frac{-\,e\,l^2 \pm \sqrt{e^2\,l^4 + l^2\,e^2\,(L^2 - l^2)}}{L^2 - l^2}$$

$$e'' = \frac{-\,e\,l^2 \pm e\,l\,L}{L^2 - l^2}$$

As the root must be positive, we get

$$e'' = \frac{e\,l\,L - e\,l^2}{L^2 - l^2} = \frac{e\,l}{L + l}$$

which means that the sections of the feeder and of the secondary conductors should be calculated in such a manner that the loss of charge in each of them should be in proportion to their lengths ; or, in other words that the sum of the sections of the secondary conductors should be equal to the section of the feeder. The total weight of the copper will therefore be equal to that of a cable calculated for the total output, with a given loss of charge, its length being equal to that of the feeder with the addition of one of the secondary conductors.

We should evidently have arrived at the same conclusion if all the receivers had not had the same intensity, the secondary conductors being all of the same length. A numerical example will best show the saving that can be effected by adopting this mode of procedure.

We will suppose that we have to supply by means of a feeder, 300 metres in length (outgoing and return wires), a centre with a constant potential, from which radiate conductors each feeding a 20-candle lamp, these wires being 50 metres long (outgoing and return wires), the lamps working at 50 volts, and the tension at the principal distribution board being 65 volts. Reckoning the lamps at 4 watts per candle, each lamp will absorb $4 \times 20 = 80$ watts (50 volts, 1·6 ampère). The feeder will therefore yield $50 \times 1{\cdot}6 = 80$ ampères.

Under the conditions described, the loss of charge in one of the secondary conductors should be

$$e'' = \frac{15 \times 50}{300 + 50} = 2{\cdot}14 \text{ volts.}$$

The diameter of the wire to be employed will be given by the formula

$$d^2 = \frac{{\cdot}021\,l \times i}{e} = \frac{{\cdot}021 \times 50 \times 1{\cdot}6}{2{\cdot}14} = {\cdot}79.$$

We will take a wire ·9 mm. ; the loss of tension in the wire will then be

$$e = \frac{{\cdot}021 \times 50 \times 1{\cdot}6}{{\cdot}81} = 2{\cdot}07 \text{ volts}$$

The diameter of the feeder must be calculated for a loss of charge amounting to

$$15 - 2{\cdot}07 = 12{\cdot}93 \text{ volts.}$$

$$d^2 = \frac{{\cdot}021 \times l \times i}{12{\cdot}93} = \frac{{\cdot}021 \times 300 \times 80}{12{\cdot}93} = 39.$$

We will take $d = 6{\cdot}3$ mm.

The total weight of copper will be :

For the feeder ...	$300 \times {\cdot}27743 =$	83·229 kg.
For the secondary conductors	$50 \times 50 \times {\cdot}0056619 =$	14·154 „
Total weight		97·383 kg.

Let us calculate the weight of copper we should have had to use if we had adopted for the derivation wires instead of a wire ·9 mm. in diameter.

1. Wires ·5 mm. in diameter.
2. Wires 1·5 mm. in diameter.

1. *Calculation of the weight of copper when employing for the secondary conductors wire ·5 mm. in diameter.*

The loss of tension in these wires is :

$$e = \frac{{\cdot}021\,l\,i}{d^2} = \frac{{\cdot}021 \times 50 \times 1{\cdot}6}{{\cdot}25} = 6{\cdot}72 \text{ volts.}$$

The loss of tension in the feeder must be

$$15 - 6{\cdot}72 = 8{\cdot}28 \text{ volts.}$$

Its diameter will be obtained by the formula

$$d^2 = \frac{{\cdot}021\,l\,i}{e} = \frac{{\cdot}021 \times 300 \times 80}{8{\cdot}28} = 60{\cdot}87.$$

We will take $d = 7{\cdot}8$ mm.

The total weight of the copper will be :

For the feeder ...	$300 \times {\cdot}42527 =$	127·581 kg.
For the secondary conductors	$50 \times 50 \times {\cdot}0017475 =$	4·368 „
Total weight		131·949 kg.

Or $\frac{131{\cdot}949}{97{\cdot}383} = 1{\cdot}36$ times as great as in the first case.

2. *Calculation of the total weight of the copper, employing for the secondary conductors wire 1·5 mm. in diameter.*

The loss of tension in the secondary wires is

$$e = \frac{{\cdot}021\,l\,i}{d^2} = \frac{{\cdot}021 \times 50 \times 1{\cdot}6}{2{\cdot}25} = {\cdot}64 \text{ volt.}$$

The loss of tension in the feeder should be

$$15 - {\cdot}64 = 14{\cdot}36 \text{ volts.}$$

The diameter of this feeder will be obtained by the formula :

$$d^2 = \frac{\cdot 021\, l\, i}{e} = \frac{\cdot 021 \times 300 \times 80}{14\cdot 36} = 35\cdot 1.$$

We will take $d = 6$ mm.

The total weight of copper will be :—

For the feeder ... $300 \times \cdot 25164 = 75\cdot 492$ kg.

For the secondary conductors $50 \times 50 \times \cdot 015728 = 39\cdot 320$ kg.

Or $\frac{114\cdot 812}{97\cdot 383} = 1\cdot 18$ times as great as in the first case.

We see, from this example, that the saving in copper effected by employing the method described for calculating the sections is important. We may also conclude that, having calculated the theoretical section to be given to the secondary wires, the section of wire employed must be immediately above this, and not below it.

A GENERAL RELATION OF ELECTROMOTIVE FORCE TO EQUIVALENT VOLUME AND MOLECULAR VELOCITY OF SUBSTANCES.

(*Continued from page* 723.)

SUMMARY OF RESULTS AND CONCLUSIONS.

BY adding together the whole of the percentage gains of *mean* E.M.F., their magnitudes likewise, and of their losses similarly, Dr. Gore found that the proportion of gains to losses was about 100 to 16·4 ; of average magnitudes about 101 to 1, and of total values about 616 to 1 ; the "losses" were probably in every case only apparent, dependent upon the kind of positive and negative metal and electrolyte, and in nearly all such cases the diluted solution had a smaller simple E.M.F. than the diluent.

The amount of effect of liquefaction and dilution upon the *mean* E.M.F. varied chiefly with the kind of positive metal, the kind of negative one, and the kind of electrolyte, and to a less extent with the kind of solvent and diluent, and the temperature and viscosity of the solution. Other experiments have shown that the effects are influenced by the rate of diffusion of the dissolved active substance in its solvent. None of these circumstances are, however, the active or essential cause of electromotive force, &c., but only the conditions which enable it to occur, and which limit its amount. The greater gain of *mean* E.M.F. by dilution of metals with mercury, than of acids, &c., with water, was probably due to the former being elementary substances, whilst the latter were compounds, and had lost much of their energy by previous chemical union.

The chief general conclusions to be drawn from this research are the following :—

1. Any circumstance which separated the molecules of a metal or electrolyte farther asunder without producing chemical change, usually increased the E.M.F. of the substance, and the amount of such increase varied with each different substance.

2. The more strongly united chemically, the electro-positive and electro-negative constituents of an electrolyte, or the two metals of an alloy were to each other, the less usually was the E.M.F. of the diluted substance. Dilution, when attended by chemical union of the diluted and diluting substances, decreased the *mean* amount of power of the two bodies to excite E.M.F. when used as an electrolyte, or as an alloy, in a voltaic cell, because they had, by such union, already lost some of their energy.

3. The stronger the E.M.F. and chemical energy of a substance, the greater usually was its increase of E.M.F. on liquefaction or dilution. The gains were usually greater with halogens than with acids, with acids than with salts, with base metals than with noble ones, and with alkali metals than with either, and larger with simple alloys than with chemically combined ones as the positive metal.

4. Experiments made to test the effects of a *series* of dilutions of an electrolyte with water, of an amalgam with mercury, and of one solid metal by another, upon the *mean* E.M.F. of the two substances, and therefore upon the *actual* E.M.F. of the diluted one, showed that the latter varied directly, and in some cases, at least, proportionately, as the degree of dilution.

5. By liquefying or diluting the positive metal by mercury, or diluting it with a solid metal, the E.M.F. of the positive metal and of the direct current were increased.

6. By liquefying or diluting the negative metal by means of mercury, the positive E.M.F. of the negative metal and the E.M.F. of the inverse or polarisation current were increased.

7. By diluting the negative ingredient of the electrolyte at the positive plate with water, the E.M.F. of that ingredient, and of the direct current, and the *mean* of that of the substance and its diluent were increased.

8. By diluting the dissolved electro-negative ingredient at the negative plate similarly, the E.M.F. of that substance and of the inverse current, and the *mean* of that of the substance and its diluent were increased.

9. By diluting the electrolyte at both plates by means of water or alcohol, the E.M.Fs., both of the direct and inverse currents, were increased ; the effects of diluting the electrolyte, therefore, were usually less simple than those of diluting either of the metals.

10. If by diluting the negative ingredient of the electrolyte the E.M.F. of that substance at the positive plate was increased more than at the negative one, that of the direct current was increased ; but if the reverse, it was decreased : this circumstance explains nearly all the "losses."

11. The effect of diluting either the amalgam or metal, or the electrolyte at the negative electrode, was usually much less than at a positive one, because of the frequently smaller E.M.F. and degree of chemical energy of the negative metal ; that metal, like the positive one, being relatively positive towards the negative ingredient of the electrolyte, but to a much less extent.

12. The degree of E.M.F. of the actual current obtained varied directly with the amount of *difference* of energy of the opposing molecular motions, and E.M.Fs. at the positive and negative plates.

13. Liquefaction and dilution acted largely like a vacuum ; by enlarging the distance between the molecules, it increased probably all the properties which depend on this, *e.g.* the E.M.F., degree of chemical energy, amount of chemical heat, &c. The opposite molecular motions of the metal and electrolyte appear to be partly converted into purely chemical action and heat, and partly into voltaic action and current ; the proportions so converted seem to differ in every case. Chemical action and E.M.F. appear to be coincident effects of molecular motion, and the former not to be a cause, but only a coincident phenomenon of voltaic current. It is well known that E.M.F. and electric current can be produced without chemical action, and that chemical union can occur without producing electric current.

14. A rise of temperature of the electrolyte from 16° to 82° C. had but little effect upon the amount of increase of *mean* E.M.F. by dilution. If, however, the temperature was sufficient to liquefy the positive metal, sudden increase of E.M.F., due to greater freedom of molecular motion, occurred at the period of liquefaction. By dilution, the volume which a dissolved substance occupies in a liquid may be caused to increase until it is much larger than that normally filled by its vapour, whilst the range of expansion of a liquid by temperature is comparatively small. Temperature also appears to act in a very different manner from dilution, and we know it often promotes chemical union.

15. The effects of using different kinds of solvents or diluents, such as water, alcohol, mercury, or even solid metals, as a means of separating farther asunder the molecules of the active substances, were substantially the same.

16. As pure dilution, either of the metal, or of the electro-negative constituent of the electrolyte, increased the *mean* E.M.F. and energy of chemical union of both, the magnitude of the effect of dilution was not entirely limited by the weaker of the two substances.

17. With some diluted solutions, the simple E.M.Fs. of which were less than that of water, such as those of alkaline salts and alkalies, there was usually a "loss" of *mean* E.M.F. during dilution, unless suitable metals were employed. The

cases of "loss," however, as much prove the chief general conclusion as those of "gain," because they were often due to the same kind of action at the negative metal as at the positive one.

18. The percentage magnitudes of gain and loss by *mean* E.M.F. may be arranged as a continuous gradation order, with the largest gain by dilution at one end and the greatest loss by chemical union at the other, thus forming a new kind of voltaic series, but of a much more fundamental and comprehensive character.

19. As the method of measuring the *mean* E.M.Fs. of substances in a small voltaic cell enables us to examine, to some extent, the internal arrangement of the molecules of metals and electrolytes, it may be conveniently employed for distinguishing between chemical compounds and mechanical mixtures, and for ascertaining the relative degrees of intimacy of chemical union and of molecular freedom of metals, alloys, amalgams, metallic mixtures, and of electrolytes generally; it also possesses a great degree of delicacy and is easy of performance.

(*To be concluded.*)

BREMEN ELECTRIC ROAD.

[COMMUNICATED.]

THE Bremen Strassenbahn Ges. has at present two of its lines equipped for electricity. They both start from the "Stadthaus," and run over the same tracks to the "Bahnhof," where they are separate, one going out to Horn and the other to the Bürgerpark. The distance from the Rathhaus to the "Bahnhof" is 900 m., from there to Horn 4,900 m., and to the Burgerpark 800 m., making the total length of the lines equipped for electricity 6·6 km., of which 2·4 km. is double, and 4·2 km. single track.

Between the Rathhaus and the "Bahnhof" there are nine curves, seven of which have radii of less than 30 m., two being of only 20 m. radius. The curves in the other parts of the line are neither numerous nor sharp, and the whole is practically level. The only noticeable grade is about 3 per cent., and 75 m. long.

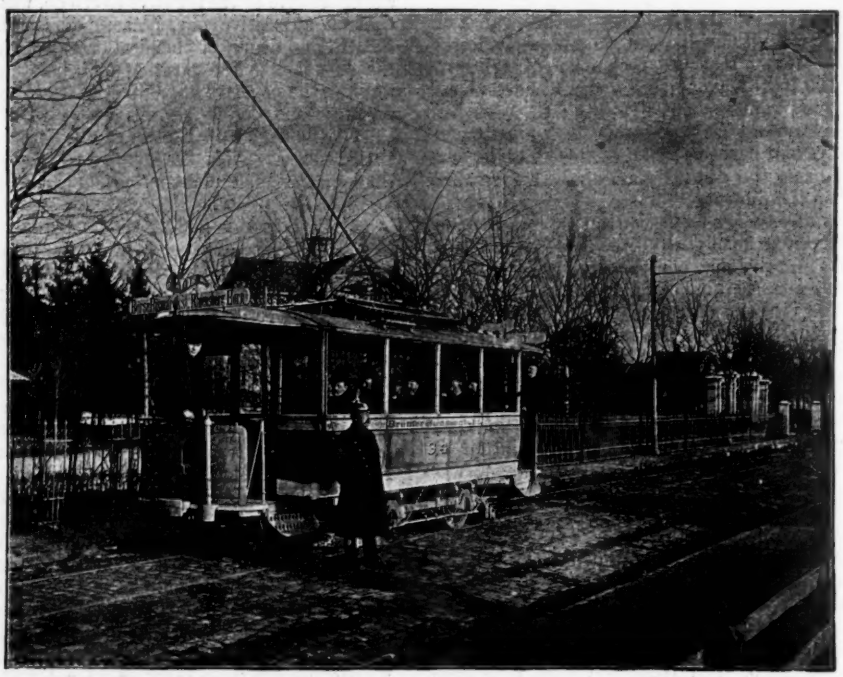
Through the built up streets, and wherever else it is practicable, the span wires are attached to the houses by means of ornamental rosettes, which at the same time act as insulators.

The poles used are made of steel tubes, and are fitted with ornamented caps and bases. Where it is possible, the poles are set between the trees, where they are almost completely hidden, and do not in the least obstruct the side walk. Where telephone or telegraph wires cross, or come near the railway line, steel guard wires are strung above the trolley wire, and on the sharp curves the trolley wire is protected by a wood capping.

The car equipment consists of 10 motor cars, six being of 24 and four of 16 seats capacity. Each car is equipped with one 15 H.P. motor, and draws a tow car when desired. In addition to the controlling rheostat and switches, each car has a fuse box and lightning arrester, and is lighted by five 16 C.P. incandescent lamps.

The maximum speed allowed is 16 km. outside, and 12 km. inside the city proper, the average speed, including stops, being 14 km. and 10 km. respectively.

The power station is situated near the line to the Burgerpark, on a branch railroad track, over which coal is brought directly to the door. The building is of brick, and is divided into three part: machine room, boiler room, and coal shed. The roof of the machine room is 10 m. high at the peak, and is supported by four iron trusses. It is covered with wood and roofing paper. The floor is of cement, and around each dynamo is an insulating platform of wood. The boiler room and coal shed have roofs of corrugated iron, and also cement floors. The complete building covers 444 square m., and is divided as follows:—Machine room, 16 m. × 13·5 m.; boiler room, 13·5 m. × 12·5 m.; coal shed, 10 m. × 6 m. The chimney is built of specially formed hollow brick, and has the following dimensions:—Height above ground, 36 m.; inside diameter at base, 1·90 m.; at top, 1·50 m.; thickness at bottom, 400 mm.; at top, 200 mm.



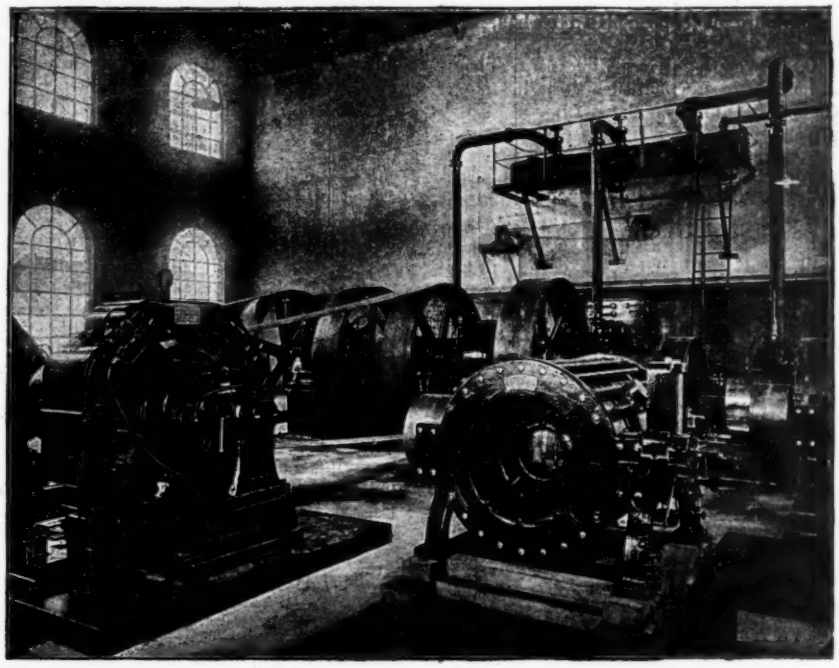
THE BREMEN ELECTRIC ROAD.

The whole area covered by the machine and boiler rooms was dug out to a depth of 4 m., where hard white sand was found. On this was spread a layer of river sand, 1·5 m. thick, well packed with water, and on this the foundations were started. The building is supported on brick piers, placed about 4 m. apart, and resting upon blocks of concrete 1·50 m. square and 75 cm. thick. A block of concrete 8 m. long. 3 m. wide, and 75 cm. thick, supports the brick foundations for three railway generators. Another block 8 m. long, 6 m. wide, and 1 m. thick, supports the brick foundation for three McIntosh & Seymour engines. The foundations of the boilers and the remaining machinery are all similar to these, but each rests in its own concrete block.

The concrete for the foundation of the chimney was started directly on the natural sand, and was carried up 2 m., at which point the brickwork commenced. The bottom layer of concrete was 5·5 m. square.

All the bricks used in the foundations were specially hard-burnt, and were laid entirely in the cement.

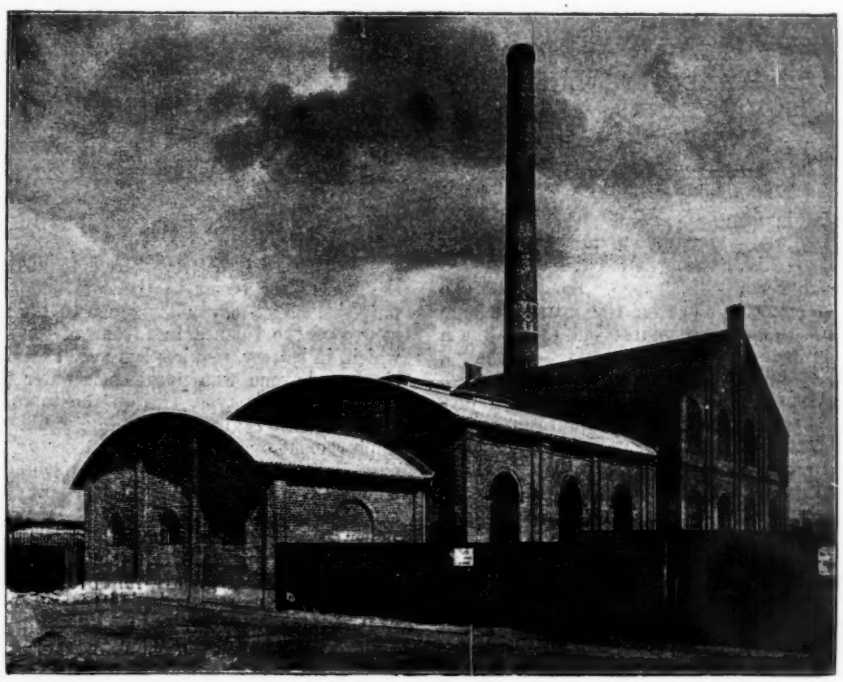
The boiler room contains two Babcock & Wilcox water tube boilers, each having 131 square m. heating surface, and designed for a working pressure of 8 atmospheres. There is also a Green's economiser of 96 pipes, two Körting injectors, and one Worthington feed pump. All the condensed steam from the engines and piping is led into an oil filter, and from there into the hot well, which can also be supplied with fresh water from the city mains and from the condenser. The pump takes water from the hot well and feeds either through the economiser, or directly into the boilers. The injectors take water from a separate tank, supplied only from the city mains, and feed directly into the boilers; either injector feeding into either boiler. The two boilers are connected to a steam drum of riveted boiler iron. On top of this drum are set the main valves, one for each engine, and from the under side a drip pipe leads to a steam trap, whose overflow is connected to the hot well.



INTERIOR OF STATION.

The steam piping is of wrought iron, with screwed or brazed flanges, and the exhaust piping is of cast-iron.

There are at present installed two McIntosh & Seymour tandem compound condensing engines, of 140 I.H.P. each, at 30 revolutions per minute, and 7½ atmospheres pressure, and one Armington & Sims simple engine of 70 H.P., at 250 revolutions per minute. All three engines are set in cast-iron bed plates, and are entirely self contained, and all have flywheel governors.



EXTERIOR OF STATION.

The two McIntosh & Seymour engines are built expressly for driving railway generators, and have extra heavy fly-wheels. Each of these engines drives direct an 80,000 watt Thomson-Houston multipolar railway generator for 500 volts, at a speed of 700 revolutions per minute. These generators are compound wound, and when desired, can be run in parallel. The brushes are of copper-plated carbon, each machine having four sets.

The Armington & Sims engine drives direct two Thomson-Houston arc light machines, which furnish light to the Parkhaus, situated about 500 m. from the station.

The condensing plant consists of a surface condenser, circulating pump and air pump, the lathe being driven from the circulating pump by a belt. The capacity of the circulating pump is 40 cm. per hour, at a speed of 60 revolutions per minute.

Water, for condensation, is obtained from a well on the premises. This well is of iron, 40 cm. in diameter, and 16 m. deep, and is guaranteed to furnish per hour 40 cm. of clear water free from sand. City water will be mostly used for the boilers, but they can also be fed from the well.

The railway switchboard consists of four slate slabs, each 2 m. high, 900 mm. wide, and 40 mm. thick, set in an ornamental wooden framework, and standing out about 700 mm. from the wall. Each slab contains the apparatus for one generator, two being now ready, the other two spaces being blank. The switches are mounted directly on the slate slabs, and all connections are made from the back. The rheostats are also placed at the back, the spindle passing through the slate slab, and having on it a handwheel and pointer. A wattmeter records all the power used by the cars, and readings are taken every hour.

The switchboard for the arc dynamos is of wood, with spring-jack connections of the ordinary Thomson-Houston form, and is arranged for two machines and two circuits.

The foundations are already built for a third engine and dynamo, which will be installed when the other lines belonging to the Bremen Strassenbahn are changed from horses to electricity. Place still remains for a fourth engine and dynamo, in case the enlargement of the system should make their instalment necessary. In the boiler room, also, there is place for twice the present boiler capacity, which is amply large for the whole equipment as now proposed.

FIGURES FOR ELECTRIC LIGHT PRODUCTION.

By W. H. BOOTH.

(*Concluded from page* 666.)

THERE is one point in connection with steam boilers to which attention has often been drawn, but which is repeatedly overlooked. This is the area of water surface in the boiler from which steam is disengaged. Some years ago there was a strong effort to place on the market a large vertical type boiler. It was then pointed out that while a large area could be had of grate surface, there was not a corresponding area of steam disengaging surface, and there was a great depth of water in which steam was being produced, and a proportionately bad tendency towards priming, one of the worst forms of loss to which a boiler is exposed. In comparing types of boilers, we may roughly assume an equal evaporation per foot of grate surface, and equate this with the water surface, and judge how far the disposition of the water surface and heating surface is favourable to non-priming. In a Lancashire boiler, 30 feet by 8 feet, there is, roughly, about 220 square feet of water surface; the level of the water, of course, being above the horizontal diameter. The grate surface of 40 feet is thus $\frac{1}{5.5}$ths the area of the water.

In a locomotive boiler, such as illustrated May 27th, the grate area is 8 feet and the water surface is about 32 feet, or the ratio is $\frac{1}{4}$ths. In an ordinary vertical boiler, with a 3 feet fire box, the ratio of the grate and water surface is about $\frac{1}{13}$ths, so that the steam must necessarily escape with a four-fold velocity, and this, of course, increases the entrainment of bubbles, or, rather, of the filmy shells of broken bubbles, especially if the water is rather thick or viscid—this latter, perhaps, a main reason why the addition of soda to a boiler causes priming in so many instances.

In a water tube boiler it is difficult to apply the rule. Though the general surface of the water in the steam drum of a water tube boiler cannot be taken as a steam escaping surface, it is hardly fair to limit this surface to the mere area of the tubes up which all the steam formed in the water tubes has to rise; for on this basis, the ratio of disengaging surface to grate surface would give an improper fraction, for the tube area is so very little; still it is obvious that there must be a very rapid rush of steam into the drum from the upper end of the sloping tubes, which are characteristic of all well-known boilers of the type of which the Babcock is best known.

This outrush probably resembles a fountain at play, at the end of the steam drum, which must inevitably throw much water into the steam space and produce wet steam. In the Babcock boiler there are two methods of connecting the water tubes to the steam drum. In one method these rise directly into the drum on its lower side, and send their contents up through the full depth of the water in the drum, but in the other form of attachment the steam drum is made shorter and the connection of the tubes is made by a short horizontal piece into the end of the drum. The circulating water with its steam is thus delivered horizontally along the bottom of the steam drum, and, from this travelling current, the steam will rise to the surface. A very considerable portion of the length of the drum is thus available as steam disengaging surface, and in this form of construction the ratio will be at least a very much better one than when the current rises vertically into the drum, and this form of construction is much to be preferred on this account, although the change was made rather with a view to other requirements, as convenience of cleaning, &c., than with the above object. Such a boiler with a grate surface of 20 feet will have a water surface of 48 feet, the ratio being thus $\frac{1}{2.4}$ths if it be all allowed, which it may fairly be, seeing that in both the best types of boiler there will also be more ebullition at the firebox end. The ratio is thus better than that of the vertical boiler though inferior to that of the Lancashire and locomotive type, and this fact may account for the frequent use of double steam drums in the Babcock boiler to increase the water surface as well as the water and steam capacity. With an ordinary single drum boiler and a firegrate 4 feet by 5 feet, the space occupied will be 19 feet by $6\frac{1}{2}$ feet, or $123\frac{1}{2}$ square feet, neglecting side passages, being about six-fold the grate surface, which is less than that occupied by a Lancashire boiler per unit of grate, and, when the highest economy is not sought, gives this boiler an advantage. It cannot, however, be employed with smoky coals, owing to the immediate cooling of the products of combustion amongst the tubes just over the grate before they have been mixed with fresh air, and combustion completed. With anthracite fuels, such as are so much used in America, where this boiler was invented, this defect disappears, and so also it does when coke is the fuel.

When placed in battery there is required a space between the boilers for access to the side doors for tube cleaning purposes. This may add so much to the floor area occupied as to turn the balance in favour of the Lancashire boiler, which, in battery, requires less ratio of floor space than when single. Anyone who possesses a water tube boiler of the long steam drum type, wherein the tubes deliver vertically and the boiler is given to priming, would probably effect an improvement by adding a loose deflector plate to turn the current from the tubes in a horizontal direction. The trouble with smoke with this class of boiler arises from causes similar to those which make the locomotive type of boiler so smoky when without the brick arch, and the application of the principle of the brick arch, which is not impossible, should greatly improve the boiler for burning bituminous coals.

For electric light work water tube boilers have been much used, very largely on account of their portability and the ease with which they have been put into existing buildings. It may be laid down as a general rule that, where a single boiler only is required, this should be considerably larger than any of two or more boilers doing double or more the amount of work. Thus, for driving 100 indicated horse-power from a single boiler, this should be considerably larger than either of two boilers driving together 200 horse-power, and very much larger than any of ten boilers for 1,000 horse-power. The reason of this is, that for the power de-

veloped the water tube boiler has a small water content, and steam is quickly raised and as quickly falls again. Where several boilers are run together in battery it would be very unlikely that they would all be at maximum or minimum conditions together, and so they give a fairly even average; but a single boiler cannot do this, and for single boilers more water capacity is required to act as a reserve of power, or as an absorber of excessive firebox heat. Water tube boilers have one advantage over Lancashire boilers which it would be unfair not to note: they have good wide furnaces with sides of refractory brickwork, and were their other furnace details more perfect should be able to give a good account of themselves, for, as already pointed out, combustion is better effected upon spacious than contracted firegrate areas.

This advantage is shared by the cylindrical return tube boiler so much used in the United States, the objection to which in this country is the firing under the shell, which is of large diameter. When clean water, free from lime salts, can be obtained, this simple boiler cannot easily be beaten by any type of boiler named. As made in America it is, perhaps, too short, but this could be remedied by placing two in line, or the shortness allowed and the surplus heat utilised in a suitable feed heater. The width occupied by the plain cylindrical boiler need not for a single boiler exceed the diameter by more than 30 inches, while in battery an addition of 9 to 14 inches will usually be sufficient. The firegrate can be as wide as the diameter of the shell, and this latter should not exceed 6 feet, for which the fire would not usually exceed 5 feet. With the larger diameters of this class of boiler the fire breadth can be made considerably less than the boiler diameter, and, after passing under the boiler bottom, the furnace gases return by the tubes and pass down side flues to the chimney. This will add to the economy of the boiler, but increase its floor area by the additional side flue breadth. All the boilers so far mentioned, except the locomotive type, require external seatings of brickwork. They belong decidedly to the type of permanent machinery. Where objection is felt to the use of brickwork, the marine type of boiler is good for large powers. The remarks made of the Lancashire boiler apply largely to the marine type, which is a combination of the Lancashire and locomotive types, and if supplied with a good draught will burn as much fuel as the Lancashire boiler; may be made about equal with it as regards smoke prevention, and has a fair capacity, and is, therefore, for electrical work, suitable as a steady steamer and an efficient evaporator, while it also possesses a fair ratio of grate to water surface as a security against priming. Apart from the question of priming, as due to deficient water surface, is that due to deficient cross section of steam space. If steam be drawn from the extreme end of a long boiler the whole of the steam must travel to that end, and if the steam space be small will sweep up some of the water. With the steam drawn from the middle of the boiler, the maximum steam velocity is reduced to half at once, while, if a long perforated pipe extend along the crown of the boiler, there need be no special longitudinal travel of the steam at all. Hence the anti-priming pipe, which is better than a steam dome—for the steam dome is in a sense a small locality to which steam travels from all parts, and steam domes are frequently found thickly plastered with mud inside, proving priming—are of very doubtful utility indeed upon a stationary boiler.

From all that has been said, it will be evident that the factors of any steam plant are the grate surface, the draught and the engine and boiler efficiency. For good all-round plant of condensing order, the indicated horse-power will approximately be 10 times the grate surface. This presupposes a fuel consumption of 20 lbs. per foot per hour, an evaporation of 10 lbs. per lb. of coal, and an I.H.P. for 20 lbs. of steam per hour. An I.H.P. may be had with, it is claimed, 12 lbs. of steam, while 15 is a common compound engine consumption, and 25 lbs. of coal may be burned per foot of grate with a good draught; but 10 lbs. of water evaporated is a very good result, indeed, and many boiler draughts will not burn 20 lbs. of coal, while it is rare to find all maxima concurrent, so the rule of I.H.P. = 10 G. is good and easy to remember, and it is a rule which, if lived up to, will imply a station better managed than perhaps the majority are. Even to practical engineers, who have not made a specialty of steam boilers, the difficulties of making a choice of suitable boilers are not to be despised, for every maker has his own ideas, and will not fail to indicate the strong points of his special type, and gloss over the weak ones. Environment has, of course, much to do with a correct choice, but as regards the powers developed by any boiler, the grate surface, or, better still, the grate breadth and length must be known, as affording some measure of the capacity to burn fuel, while the various items referred to in the present article should not be neglected. Never pay the slightest attention to any statement as to rapidity of raising steam from cold water. A two-inch sphere of thin copper, half filled with water, will be quicker burst by the steam generated in it, if placed in a good domestic fire, than any known steam boiler will raise a pound of steam, and yet this forms an instance quite as rational as any claim for quick steaming as economical, for quick steaming implies insufficient water capacity, and quick steaming boilers find their proper place, perhaps, only when applied to fire engines, for which they are commendable, but not in an electric light works. There is a small loss due to very large water capacity when a boiler is worked a mere fraction out of the 24 hours; but the loss is partially, if not entirely, compensated by greater steam dryness, and is not at any time a heavy item. Into the strength of boilers it would be out of place here to refer further than that any known boiler may be had from a good maker equal to 200 lbs. pressure.

THE CURRENT THAT KILLS.

II.

SINCE our article of last week was written, interesting and valuable information on this subject has come to hand in the form of a full report on the seven cases of electrocution that have been perpetrated in America, by Dr. Macdonald, who was present at them all. This report was read at a meeting of the New York Academy of Medicine, and was followed by a discussion.

Such a document, and the remarks it called forth in an assembly of medical men, must command the serious attention of those who are interested in the question of the current that kills, or who in any way desire to arrive at the truth in this matter.

We, on this side of the Atlantic, are fortunately not (yet at any rate) interested from the electrocutionist's point of view, but rather, and more happily, from the point of view of the safety of the public, and of that ever increasing, and for the most part, careful body of men, who handle and otherwise deal with the currents which supply electric light and power. Still, we may with advantage follow the report, and consider, mainly from the electrical side, some of its records and statements. In doing this we will avoid the more gruesome details as far as possible.

That the American authorities had a difficult and unpleasant task before them in preparing for and carrying out electrocution to its practical issue, no one will deny, nor is the little sympathy they have met with to be wondered at. Medical men were naturally looked to for considerable aid in the matter, and while we are glad to remember that their province is to save life rather than to destroy it, we cannot help feeling somewhat amused at the remarks of one of their number, who, during the discussion, raised an indignant protest against the consideration of such a subject by medical men. We suppose the old joke about medical men being licensed to kill has never been heard of in New York. Be that as it may, it is satisfactory to note that many of the profession have, in a proper spirit of scientific investigation and desire to arrive at the truth, given their aid towards making the proceedings as humane as can be.

The first point that strikes us on reading the report, is that the whole business has been overdone, and a false idea of safety from contact with smaller currents thereby established. This is no doubt partly due to a very laudable desire to make sure of inflicting a rapid and painless death, but partly, we think, to a misconception of some of the more important electro-physiological factors in the problem that had to be solved. In our article of last week we pointed out certain conditions which must necessarily be present before an electric current can be fatal to human life, and it is curious to note that some of these do not seem to have

occurred to the electrocutionists, or at least to have been considered by them. We stated that the rate of alternation is a factor worth serious attention, and that the current must pass so as to include the vital organs in its direct line of flow. The last point received only slight attention, while the first was passed over entirely.

With reference to another point, we find the statement made, apparently in all seriousness, for it becomes the key to all their subsequent arrangements, that no human being could survive an alternating current of more than 1,500 volts for 20 seconds. And yet they knew, or might have known, that their electrical confrère, Tesla, had survived, and even constantly handled with impunity, voltages more than 10 times as high. Many others on both sides of the Atlantic have handled more than 1,500 volts without any ill effect. The writer remembers taking, inadvertently, 10,000 volts on one occasion, the only effect of which was to produce a slight burn on one finger, and cause him to utter a word which becometh not the lips of right minded electricians. If these enormous voltages can be thus taken with safety, and no one can now doubt it (of course, provided always that the quantity of current carried by them be sufficiently small), it is quite clear that there is no use in looking to this factor of current flow for the fatal effect. All useful work which is done in the thousand and one applications of electricity to our daily need and comfort is done by the quantity of current that flows. Be the effect desired thermal, chemical, mechanical, or magnetic, it is all the same. Sufficient pressure or voltage is, of course, necessary to overcome the resistance in the circuit, but it is to the ampères that we look for the useful effect. Why then should it be supposed that this is altered, and the effect of voltage everything, and of ampèrage nothing, in the action of currents upon the human body? One of the functions of the current relied on is the electrolytic, and surely if it is wanted to produce electrolysis, the laws which govern its production cannot be ignored.

One gentleman, indeed, expressed himself in favour of the view that it was the watts that killed, and from that argued that in order to make sure of the victim, what he called 40 *horse-power death* should be administered. Fancy an expenditure of energy to the extent of 40 *horse-power* being necessary to drive the life out of one miserable specimen of humanity.

The idea of the watts is doubtless more reasonable than that of the volts, but it is easy to see that inasmuch as watts are the product of volts and ampères, these factors may be so adjusted that for any given number of watts the volts may be so few as not to overcome the body resistance, or again that only a small and perfectly harmless fraction of an ampère may pass through it. Of course, the effective current can be expressed in watts, but the term may mean anything or nothing as regards fatal possibilities, so that any attempted definition of a fatal current as so many watts of electrical energy, must necessarily be incomplete.

(*To be continued.*)

THE CHEMICAL THEORY OF LEAD ACCUMULATORS.

By M. G. DARRIEUS.

(*Continued from page* 726.)

PHYSICAL AND CHEMICAL CONSTITUTION OF THE ACCUMULATOR AFTER DISCHARGE.

1. *Positive Plate.*—The positive material discharged has not the same appearance as the material charged; it has a lighter and somewhat reddish tint.

The positive active material, after discharge, on being treated with nitric acid, is partly soluble: this result is of importance, as it shows that the physical constitution of the material has undergone a modification, owing to the electrolytic action of the discharge, after which we find in the plate leaden compounds below PbO^2. The neutral acetate of ammonia partly dissolves this material, which leads us to suppose that the soluble compound is an oxide of lead, PbO, and not metallic lead, or that it also contains sulphate of lead; the positive active material after discharge would therefore be a mixture of PbO^2 and PbO, the latter being in a quantity which is the function of the electrical energy supplied for the discharge.

The above experiments have only a qualified value; they require to be confirmed by more exact analyses.

The method is the same as before; if we have to deal with an oxide which is still equal to PbO^2 after the discharge, the quantity of chlorine collected by the decomposition of the hydrochloric acid will be the same as before. If PbO exists, on the contrary, the formula to be employed is no longer the same, and the smaller quantity of chlorine collected will be given by the equation

$$PbO^2 + PbO + 3HCl = 2PbCl + 3HO + Cl.$$

This method, in fact, gives volumes of chlorine far below those found for the positive material charged; the figures found are often very variable, for they depend on the total quantity of electricity supplied for the discharge. We must therefore attribute to them only a relative value serving to indicate the change of condition of the material. Thus several analyses have given figures varying between ·18, ·201 and ·21 of a gramme of chlorine for 1 gramme of material. The reduction of the peroxide to a weaker oxide seems therefore undoubted; but we must also find out whether the active material after discharge does not contain sulphate of lead. If we take for granted the theory most generally admitted up to the present, the importance of this point will be appreciated by everyone.

With this object, samples of discharged active positive material are washed first in cold water, in order to avoid, as far as possible, any local action that might arise, then in warm water, until the free sulphuric acid is completely eliminated. The residue, on being treated with carbonate of soda and chloride of barium, enables us to measure, by means of the sulphate of baryta, the quantity of sulphate of lead existing in the sample.

By proceeding thus, we find that after discharge the positive plate also contains sulphate of lead, but in varying quantities, which are not functions of the ampère-hours supplied for the discharge.

The results furnished by the analyses are given in the following table. On consulting these figures, we can see that the total quantity of peroxide reduced depends on the ampère-hours of the discharge, but that that of the sulphate is *essentially variable.*

Table containing the Results of Analyses made of the Active Positive Material.

The samples of active material were taken out after each charge and each discharge from an apparatus containing 2·3 kilogrammes of positive material.

No. of experiment.	Analysis after charge.		Analysis after discharge.		Oxide of lead formed during the discharge.	Sulphate of lead formed during the discharge.	Ampère hours supplied.	Sulphate of lead corresponding to the ampère hours.
	Oxide of lead, PbO.	Sulphate of lead.	Oxide of lead.	Sulphate of lead.				
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.		Per cent.
1	2·33	3·6	8·72	4·41	6·39	·81	86	21·12
2	·21	·47	6·97	4·40	6·76	3·03	114	28·00
3	·40	·90	8·40	2·18	8·00	1·28	120	29·47
4	·38	·40	5·56	2·14	5·18	4·74	82	20·14
5	2·44	·95	10·92	4·01	8·48	3·06	121	29·71
6	1·47	·19	6·65	1·16	5·18	·97	76	18·65

A last experiment gave 2·75 per cent. of SO^4Pb after a discharge of 11 ampère-hours per kilogramme; the quantity of SO^4Pb would have been 27 per cent. if there had been sulphatation in proportion to this discharge.

2. *Liquid.*—The transformations observed at the end of the discharge in the liquid are reduced, as we all know, to a variation in density, the density being less at the end of the discharge than at the beginning; moreover, the reactions of the persulphuric acid become weaker and weaker as the discharge goes on.

3. *Negative Plate.*—As with the positive plate, the appearance of the plate is not the same after a discharge (in this paper we have only entered into normal discharge, *i.e.*, stopped at 1·8 volts); the tint of the material is somewhat duller than at the commencement, when it has a very metallic character. The method employed for finding out what modifications have been produced in the molecular condition of the active material is still the same, being based on the treatment with hydrochloric acid of samples of known weights of discharged active material.

The quantity of hydrogen gives, on comparison with the figures found for the charged material, the measurement of the transformation due to the discharge.

Measurement of the Volume of Hydrogen Furnished by Treating the Negative Active Material after Discharge.

Experiments.	Weight of material treated.	Volume of hydrogen collected.	Temperature.	Barometric pressure.	Volume of hydrogen brought to 0° and 760 mm.	Volume of hydrogen in proportion to 1 gr. of material.
	gr.	cc.	degrees.	mm.	cc.	cc.
I.	·984	78	18	765	73·5	74·2
II.	1·133	88	20	754	81·3	71·3
III.	2·072	164	20	770	157·5	76·0
IV.	1·720	138	18	761	129·7	75·0
V.	3·892	304	20	772	288·8	74·2
VI.	2·431	193	20	760	177·5	73·0

Which gives for the mean volume of hydrogen per gramme of material 74 cc. This result, which is considerably below those furnished by the charged material has, moreover, only a qualified value, as showing the presence in the material of an oxide or salt of lead which does not give off hydrogen on being attacked by hydrochloric acid; thus there has been an elimination of part of the free lead.

To obtain figures of a quantitative value, we must find out whether sulphate of lead really exists in the material discharged, and, if so, in what proportion.

The search for this sulphate of lead was made by a method analogous to that employed to find the same body in the positive. The sample of active material taken out of boiled water, so as to avoid any possible local sulphating, if the material contained an oxide, was freed from sulphuric acid by being washed in boiled water, without this active material ever having been in contact with the air. When the last traces of acid had disappeared, the sample was treated with a boiling solution of carbonate of potash, then with chloride of barium, the proportion of sulphate of baryta formed serving to measure the initial weight of sulphate of lead. It is necessary to add, moreover, that the water used for the washings was collected and precipitated in order to guard against errors in the method.

The sulphate of lead in the negative had also been measured before the commencement of the discharge; the results furnished by several experiments are summed up in the following table:

Experiments.	Weight of active material contained in the experimenting apparatus.	Ampère hours supplied for the discharge.	Proportion of sulphate of lead before the discharge.	Proportion of sulphate of lead after the discharge.	Proportion of sulphate of lead due to the discharge.	Proportion of sulphate of lead corresponding to the discharge.
	kg.		per cent.	per cent.	per cent.	per cent.
1	44	2,113	1·30	25 25	23·95	27·3
2	44	1,973	·88	23 78	22 90	25·4
3	44	1,960	2·25	33·42	31·17	25 2
4	44	2,025	2·14	26·80	24·66	26·07

We need only at present call attention to the agreement between the figures in the two last columns. We may mention, lastly, that the active material when discharged and heated by the blow-pipe is transformed in parts into litharge, becoming incandescent.

(*To be continued.*)

ELECTRIC LIGHTING AT SOPHIA.

[FROM OUR OWN CORRESPONDENT.]

AFTER studies and negotiations carried on for more than two years, an agreement was finally concluded for erecting the projected electric works for lighting the city of Sophia, and the operations for the completion of this extensive and truly interesting work have been taken in hand.

In July, 1891, a negotiation for allotting these works was held, in which the principal European firms participated. A commission was formed to examine the tenders, consisting of the Burgomaster Petkoff, the director of municipal buildings, Markoff, the chief engineer, Nestoroff, the chief engineer of the State railways, Momtschikoff, and the city engineer. As technical experts, Prof. Dr. Erasmus Kittler, of Darmstadt, and Prof. Schlenk, of the Technolological Museum of Vienna, were engaged; but the former of these did not make his appearance, so that Prof. Schlenk alone undertook the technical investigation of the tenders.

This, strictly speaking, was from the outset an impossible task, since free scope had been left to the parties tendering, both as to the system selected and the details of its execution. Hence the tenders submitted differed in the most important points, so that it was simply impossible to find a uniform basis for comparison. Nevertheless, the expert undertook this difficult task, the fulfilment of which had been allotted him, and attempted to complete it by drawing up a uniform basis for all the tenders. In what manner he effected this will appear from the literal reproduction of his report as published in the official organ of the city.

Report on the Tenders of the First Issue for the Electric Lighting of the City of Sophia.

In the Session of the Commission, July 4—16th, 1891, there were submitted six tenders which had been sent in up to the date decided. The tenders were from the following firms:

Compagnie Continentale Edison, of Paris.
Crompton & Co., of London.
Ganz & Co., of Buda-pest.
Siemens & Halske, of Berlin and Vienna.
B. Egger & Co., of Buda-pest and Vienna.
Schuckert & Co., of Nürnberg.

On reading the tenders, the commission found that those of the Compagnie Continentale Edison, and that of Crompton, did not respond to the conditions of the prospectus, as the former excluded hydraulic motors and the latter only contemplated lighting the interior portion of the city. In consequence, the commission only took the four remaining tenders into consideration.

As it appears from the documents, some of the firms in question have not confined themselves to a single project, but have drawn up alternative proposals. Of all these projects, only those form the subject of the following report which permit of the utilisation of the entire fall of water and in which the leads in the main streets are placed underground.

The alternating current system, with transformers, has been taken as a basis for all the tenders, as it has proved satisfactory in practice and is best suited to the local conditions. In the first place, all the tenders had to be calculated on a uniform basis, so as to render a numerical comparison possible. The installations proposed differ not merely in the construction and strength of the motors, but also in the quality and quantity of the lamps and the manner of their introduction into the circuit.

Considerable differences have also to be noted in the projected water-courses (for the supply of power) and in the effect of the dynamos. In some of the tenders there is no mention of tolls and customs. The appended table contains figures which serve for a comparison of the tenders.

The tender of Ganz & Co. contains an installation of motors consisting of two turbines, each of 700 H.P., representing a total effect of 1,400 H.P. In all, five alternating current machines are proposed, two of which, at 300 H.P., are to serve for the lighting of the main streets with 106 arc lamps at 16 ampères and 440 glow lamps at 32 normal candles. The remaining three machines were to serve for lighting the side streets, which was merely provided for in the description but not in the estimate of cost.

On the other hand it is to be seen that only four dynamos can be worked with the two turbines proposed by Ganz & Co., and that a third turbine will be required for the remaining fifth dynamo, since the total effect must amount to 2,100 H.P. On this account the cost of the turbines has been increased in the table by one-third.

As in the tenders of some firms there is no mention of a travelling crane, nor of reserve parts, these appliances, for the sake of comparison, have not been included in the table. The firm, Ganz & Co., have proposed riveted wrought-iron water-mains of suitable dimensions. It can be scarcely assumed that no defect will occur in a water-course of 4½ kilometres, and as no duplicate is provided in the case of repairs, an interruption of the lighting might occur. With regard to this circumstance it is rational to assume a duplicate water-main. Hence the price of a second main was added to the estimates of Ganz & Co. and Egger & Co., under the heading of supplementary fittings. Siemens & Halske propose three lines of piping, two of which can keep the entire installation in action. Schuckert & Co. propose two water-mains. In the table there is also an omission of sums for unforeseen cases, and for alterations which depend on local conditions; the charges for excavations, &c., in laying down the mains and cables. Some firms give an approximate estimate, but others calculate only on earth and not on rock. Hence a comparison is impossible, and these items, consequently, do not appear in the table.

As regards the telephone installation it must be remarked that their expense is also omitted, as the amounts of the several firms differ greatly. The firms, Egger & Co. and Schuckert & Co., offer a much larger telephone net than the others, connecting the municipal buildings and the five police districts with the central station. The charges for dynamos include all the necessary auxiliary machines and appliances completely fitted. The firms, Egger and Schuckert, include under this head the transformers for the primary and secondary stations. The illuminating plant includes not the lamps alone, but the accessory transformers.

The office and engineer's charges are filled in when the respective firms have stated them separately. Where this has not been done, they are included in the separate prices. It must in general be remarked that nearly all the firms have not followed strictly the stipulations of the prospectus. In my opinion this is not a fault, as many points of the prospectus demand arrangements which are no longer in use, or the execution of which would occasion much outlay without any corresponding benefit. It is to be remarked that the figures in the table serve only for a comparison and indication which of the firms demands the smallest amount per unit; these figures do not represent the actual cost of the installations. The totals show that Schuckert & Co. (alternating current system) is the highest; besides an addition should rightly be made for tolls and customs to the extent of 10 per cent. of the entire sum; further arrangements for safety, freight of 888,000 kilos. of mains, and an amount inaccurately stated in the tender for managing the building which the firm require extra and which has not been included under the seventh heading. The total amount of this firm is 3,001,954 francs.

It must also be mentioned that this firm introduces 30 arc lamps in one series at a tension of 2,000 volts, which is not greatly to be recommended. The tender states further that five glow lamps are to be lighted with 700 volts, whence it must be concluded that a great number of lamps are introduced in one series, though it is not stated in the tender what measures are taken to maintain exact working. Above all things this series method is disadvantageous and besides this tender lays down too high figures.

The second tender of this firm with the use of a rotatory current which is converted into a continuous current, is not only considerably higher than the former, but it is also less suitable and this system has, therefore, not been taken into consideration in the competition.

The next lowest figure is that of Egger & Co., *i.e.*, 2,691,940 francs, with relatively high prices for the motors; the latter give only an effect of 1,200 H.P., whilst those of Siemens and Halske give 3,000 H.P., and those of Ganz and Co., 2,100 H.P.

Egger & Co. tender rotating currents, the advantages of which, as compared with the alternating current, have not been demonstrated in practice. In the transfer of power the new rotatory current system has certainly given brilliant results and it will probably prove as successful for lighting.

According to the table the next lowest figure is that of Ganz & Co., 2,508,104 francs. At first sight this tender seemed the cheapest. But various additions were necessary, *e.g.*, tolls and customs. In order to arrive at a fair comparison with other firms it was necessary to increase the number of the turbines as appears in the table so that their total effect might reach 2,100 H.P. The cost of a duplicate water course had also to be added. When this tender is compared with that of Siemens & Halske we see that the latter amounts to 2,494,588 francs, *i.e.*, 13,516 francs less than Ganz & Co. In favour of the tender of Siemens and Halske it must be mentioned that the total effect of their turbines is greater by 900 H.P. The dynamos of Siemens and Halske give 90,000 watts more (at 1,000 H.P. of the turbine and 330,000 watts of the dynamo reserve), and the efficacy of the leads is 150,000 watts greater than in case of Ganz & Co.

On the other hand is the fact that Siemens & Halske in street lighting have 118,000 watts, respectively 980 glow lamps at 30 normal candles. This advantage of the firm Ganz & Co., in comparison with the above mentioned superiority of Siemens & Halske, is not great, the rather as the construction of Siemens & Halske's glow lamp is more convenient. Hence the higher figure for the lamp in Siemens & Halske's tender is intelligible, notwithstanding their smaller number.

COMPARATIVE TABLE OF THE TENDERS FOR THE ELECTRIC LIGHTING OF THE CITY OF SOPHIA.

No.		SCHUCKERT & CO.	EGGER & CO.	GANZ & CO.	SIEMENS & HALSKE.
	Effect of installation of turbines.	3 turbines at 350 H.P. = 1,050 H.P.	2 turbines at 660° = 1,320 H.P.	3 turbines at 700 H.P. = 2,100 H.P.	3 turbines at 1,000 H.P. = 3,000 H.P.
	Electrical effect. For public lighting.	130 arc lamps at 12 amps.; 250 arc lamps at 9 amps; 662 glow lamps at 29 normal candles.	138 arc lamps at 10 amps; 2,880 glow lamps at 15-30 N.C. about 235,000 watts.	142 arc lamps at 16 amps. 400 glow lamps at 32 N.C.; 3,400 glow lamps at 16 normal candles = 382,000 watts.	2,200 glow lamps at 25 to 30 N.C., together 264,000 watts.
	Effect of dynamo	3 at 22,000 watts = 660,000 watts.	4 at 180,000 = 720,000 watts.	5 at 180,000 = 900,000 watts.	3 at 330,000 = 990,000 watts.
	Total effect of leads	Nothing stated in tender.	Three times greater than in the original installation.	142 arc lamps at 16 amps.* 400 glow lamps at 32; 8,900 ditto at 16 = 520,000.	1,200 glow lamps at (?) N.C.* and 3½ watts = 672,000 watts.
1	Turbines	124,656 francs.	96,700 francs.	71,693 francs.	158,700 francs.
2	Water mains	753,360 „	708,720 „	411,873 „	905,445 „
3	Dynamos	288,240 „	332,400 „	230,142 „	265,540 „
4	Leads	856,800 „	380,620 „	804,567 „	737,343 „
5	Lamps	432,900 „	400,620 „	270,440 „	319,660 „
6	Buildings	230,436 „	50,000 without houses	102,000 „	90,000 „
7	Office and engineer's expenses	60,000 „	... ...	103,544 „	1,000 „
8	Telephone installation ...	9,000 „ Tolls and customs.	14,600 francs. For double water course.	2,015 „ For double water course.	Without pillars (1600) 7,900 francs.
9	Additions and alterations ...	246,502 francs.	708,720 francs.	411,873 francs	... ...
	Sum total	3,001,954 francs.	2,691,940 francs.	2,508,104 francs.	2,494,588 francs.

* There is apparently some misplacement of these items.—EDS. ELEC. REV.

As regards the great difference of price in the turbines of Ganz & Co., and of Siemens & Halske, we must consider that the turbines of Ganz & Co., make 550 rotations per minute, and those of Siemens & Halske 300 rotations. For a greater number of rotations a smaller turbine can be selected, of less weight and lower price. The greater number of rotations (about 73 per cent. more has the bad result that a dynamo is fixed on the same axle on both sides of the turbine); the axle rests on several bearings, whence the action will be less certain as at a lower rotation. If the tender of Ganz & Co. is compared with that of Siemens & Halske a fourth turbine must be added and about 24,000 francs must be added to the price. The water mains which Siemens and Halske propose have an advantage as they are rolled pipes without a seam (Mannesmann's pipes).

A comparison of the working costs is impossible as no sufficient data are available. There is no doubt that the working costs will not greatly differ.

(Signed) PROF. SCHLENK.

Sophia, *July*, 1891.

Under the conditions already mentioned we need not wonder that the Commission for lighting the city of Sophia declined to follow the conclusions of a report based upon mere subjective impressions, and resting upon unverified suppositions and assumptions. The commission resolved therefore, to advertise for new proposals upon a perfectly uniform basis prescribed to the competitors as *conditio sine quâ non*, so that no difficulties should be encountered in comparing the tenders submitted. At the same time the commission resolved not to call foreign experts to examine the tenders and accordingly Prof. Schlenk was this time not invited.

In spite of the precaution adopted rather important differences still appeared among the tenders, especially as regards the manner of placing the leads within the city. Still the possibility of a rational comparison was brought nearer. After the examination had taken place the commission made public the following report:—

Report on the Tenders of the Second Invitation Concerning the Electric Lighting of the City of Sophia.

The tenders submitted on the first advertisement (July 1st) by the firms Schuckert & Co., Egger & Co., Ganz and Co., Siemens & Halske, Crompton & Co., and Edison and Co., for the electric lighting of the city of Sophia, differed in the system selected and in the extent of the installation, in consequence of which a correct comparison could not be reached. In consequence, the commission proposed to draw up a supplementary prospectus which contains clearly the demands for the lighting of the city and to call upon the same firms to submit new tenders. The municipality sanctioned this proposal of the commission and issued a new advertisement.

In reply, there appeared again six tenders by the firms above mentioned. The tenders were submitted to the commission for testing and comparison, which took place in its sessions of August 21st, 22nd, 23rd, 24th, 26th and 27th, and the results are published in the accompanying tables. In addition the tenders contained the requisite explanations on the several statements as given. The former indications which gave as a whole the quantities, quality and dimensions of the leads are now stated for each separate part of the leads. Some of the tenders are deficient in these explanations, and the amounts for the various parts of the installation are grouped differently and given as a whole, whence it was impossible for the commission to include all the items in a single group. Thus the first category of the tender by Siemens & Halske contains merely the cost of the water-course between the reservoirs and the machinery house. In Crompton's tender we find in the same category, besides the cost of the water course, that of the machinery house and the installation of turbines. On comparing the tenders the commission found that some of these were not in accordance with the initial prospectus. Above all things this programme required separate tenders for the aerial and the underground leads, whilst the firm of Edison proposed only aerial leads, and Schuckert & Company only subterranean leads. Egger and Company made a new proposal, not included in the prospectus, *i.e.*, to carry the primary lead below ground, and the secondary above ground. The commission thought well to divide all the tenders in three groups, as follows:

a. Tenders with exclusively aerial conduction.

b. Tenders with subterranean primary conductors and aerial secondary conductors.

c. Tenders with exclusively underground conductors.

In consequence of this classification we obtain the comparative charges in the various tenders for comparison for the quantity of the wrought iron pipes which some firms have given too small. This item is given extra in the table. Accordingly the tenders as regards their advantages may be placed in the following order:

a. Tenders with exclusively aerial leads—

1. Ganz & Co., 1,912,177 francs 58 cents.
2. Siemens & Halske, 2,389,577 francs 20 cents.
3. Edison & Co., 3,541,000 francs.

The firms Schuckert and Egger & Co. made no offer.

Crompton & Co. submit a project, according to which a part of the main lead from the city boundary to the central station will be placed underground. The amount is 2,171,500 francs.

b. Tenders with main lead underground and secondary lead in the air.

1. Ganz & Co., 2,081,861 francs 28 cents.
2. Crompton & Co., 2,292,750 francs.
3. Egger & Co., 2,520,662 francs 85 cents.
4. Siemens & Halske, 2,572,539 francs 10 cents.

Edison and Schuckert make here no proposal.

c. Tenders with primary and secondary leads both underground.

1. Ganz & Co, 2,423,249 francs.
2. Crompton & Co., 3,077,750 francs.
3. Siemens & Halske, 3,100,073 francs 20 cents.
4. Schuckert & Co., 3,394,290 francs.

The firms Edison and Egger & Co. do not tender.

The Members of the Commission:—Municipal Councillor Dpetzkoff; director of the technical department of the municipal buildings, T. Markoff; head engineer for streets and highways, N. Nestoroff; head engineer of the state railways, Momtschikoff; and the City Engineer.

On the basis of this second report, after long consultations, it was resolved to entrust Ganz & Co. with the undertaking, and the agreement was concluded as above mentioned.

According to the agreement the above firm is entrusted with furnishing all the appliances and their installation, as also with the erection of the machine house and dwellings. The central station will be placed near the Bojana hamlet at about 7 kilometres from the city. In the machine house the turbine room will be separated from the dynamo room by a row of cast iron pillars, which serve as support for a glass wall. By this division the cold, damp atmosphere of the turbines is prevented from entering into the dynamo house. Through the machine house there run two travelling cranes, each able to raise 3,000 kilos, in order to facilitate the erection of heavy machinery.

In the turbine room three turbines with horizontal axles are set up. The entire water course of more than four kilometres must be constructed entirely of Mannesmann piping. In the dynamo room are set up three alternating current machines, each for 460,000 watts at 3,300 volts, and about 450 rotations per minute, together with their exciters, which are coupled directly to the turbines.

Next to the machine hall comes the room for the distribution. In the prolongation of the machine house are two rooms, one of which serves as a telephone and testing room, and the other for placing the supplementary rheostats (banks of lamps).

The lead from the central to the city will consist of naked aerial wires, whilst in the city subterranean concentric cables are laid down.

For public lighting there are planned in the first place 1,000 glow lamps and 100 arc lamps, half of which burn for the entire night and the other only for half the night. In the first period of working the Prince's Palace, the Sobranje, and the State Printing Office as well as several municipal buildings are to be connected with a total consumption of 150,000 watts.

The entire installation must be completed within two years, but the working on a small scale will begin earlier.

D

ELECTROSTATIC ALTERNATORS.

BY T. H. MURAS.

IN March, 1890, while endeavouring to produce an alternating current for laboratory use, it occurred to me that a suitable current might be obtained from an electrostatic machine designed on the same principles as electro-magnetic alternators, and I designed such a machine, which, however, was not then constructed. After some preliminary experiments, I have recently made such a machine.

Before describing this it may be pointed out that an alternating discharge can be obtained by electrostatic induction in the apparatus illustrated in fig. 1, where a continuous current machine, E, such as a Wimshurst, charges a condenser, L; the outer coatings of condensers, F, A, are intermittently charged through spark-gaps, and discharged through a spark gap, P. As this occurs, currents pass the spark gap, D, to supply induced charges on the inner coatings, A, and their alternating character may be shown by inserting a vacuum tube at D. In this apparatus there is no mechanical movement, and no mechanical work is done, so that it only converts a continuous to an alternating current, with loss in the process.

Instead of intermittently charging the outer coatings, F, of fig. 1, they may be permanently charged by the continuous

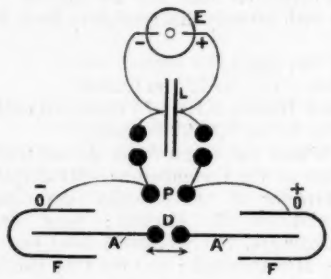


FIG. 1.

machine E, fig. 2, and the electrical alternation of charge replaced by mechanical alternation of position of the outer and inner coatings, F, A. This is effected in the machine illustrated in fig. 2, where the permanently charged outer

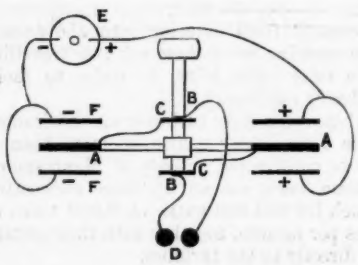


FIG. 2.

coatings or field plates, F, are stationary, and the inner coatings, A, are sectors revolving within the field plates. Each sector, A, is permanently connected by a conducting ring, C, with a stationary brush, B, and a terminal, D; alternating currents pass the terminals, D, when the sectors, A, are revolved. This machine converts mechanical work to electric current with high alternating difference of potential, the output depending on the mechanical power supplied, and not on the output of the exciting machine, E, which only furnishes the first charge and makes up for leakage. The revolving sectors in this machine might carry the permanent charges, and the stationary ones receive the induced charges. Actual mechanical reciprocation might be used instead of rotation, but would obviously not be a good arrangement. I made a small machine of the construction shown in fig. 2, the two movable sectors being carried by a rotary ebonite disc of six inches diameter. The two field-plates were at first made of thin zinc, bent to enclose the edge of the disc. Afterwards the field-plates were sectors similar to those on the disc, and secured on the outer surfaces of fixed glass plates. Very little result was obtained from this machine, and it was obviously too small.

Instead of using only two revolving sectors and two pairs of fixed ones, as in fig. 2, any number may be employed, alternate sectors being connected together, as represented in the concentric diagram, fig. 3, where eight sectors, A, are

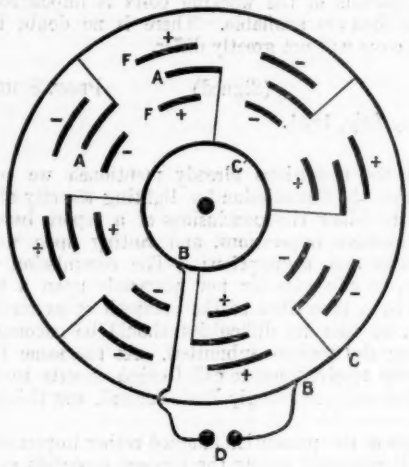


FIG. 3.

shown as moving through eight pairs of field plates, F. The sectors, A, are connected to two collecting rings, C, C, which are connected by brushes, B, to terminals, D. The sectors, A, may be placed on the periphery of a rotating drum, with one collecting ring on each end; or the drum may be reduced to a disc, with each sector extending from the edge on both surfaces, and a collecting ring on each surface. Fig. 4 is a front view of a machine made on the latter plan.

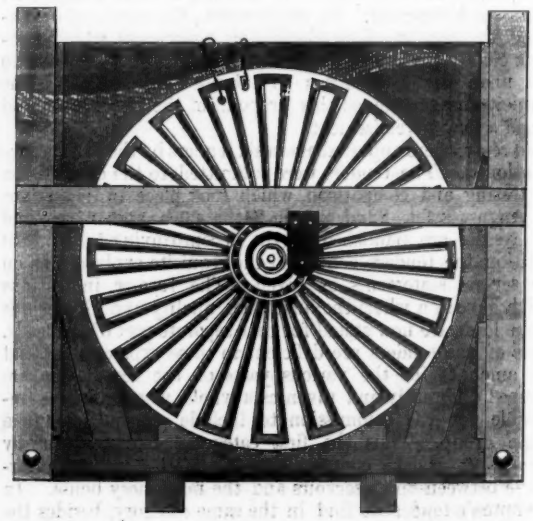


FIG. 4.

having 40 sectors on the armature disc, which is of ebonite, 46 cm. in diameter, carried by one end of a pulley shaft. The sectors cover a large part of the disc, the insulating

spaces between them being only ·8 cm. wide. The field sectors are carried on the outer surface of two fixed glass plates, 56 cm. square, which are supported at the edges by a wooden frame, and have central openings for the shaft and brushes making contact with the collecting rings on the disc; one of these rings is shown in the illustration, with the corresponding brush-holder support. Each brush consists of a few very thin phosphor-bronze wires. Alternate sectors on each field plate are connected by inside and outside rings. The total effective area of all the sectors on the disc is 1,968 square cm., or over 2 square feet. The glass plates are each ·19 cm. thick, the disc ·5 cm. thick, and the space between the inner surface of each plate and the disc about ·5 cm. The field plates are charged by a small Wimshurst machine to the maximum possible without sparking across the insulating surfaces; this sparking occurs with a potential difference corresponding to a discharge only ·25 cm. long in air, and definitely limits the spark length obtainable from the machine. This and all other sparks for measurement were taken between brass balls, not particularly well polished, ·95 and ·84 cm. diameter respectively. The sparks obtained from the machine are about 1 mm. long, corresponding to about 3,000 volts. From the above data a rough estimate may be made of the current obtainable from the machine, from which it appears that the maximum possible at 500 revolutions per minute is 1 milliampère.

The following are some of the results obtained from a considerable number of experiments with the machine running at between 800 and 900 revolutions per minute. The spark length is about 1 mm. at any speed. While sparks are passing, the discharging balls can be separated a little more, but the sparks will not start over the increased distance. Strong white sparks are produced, one for each passage of the sectors, or 600 sparks per second at the higher of the above speeds. If the sparks are discharged in the front of the machine the moving sectors are seen at about half-way between the stationary ones. The discharge is perfectly regular, as can be seen with a moving mirror giving separate images of them. Discharges between brass balls, or iron or carbon points, differ only slightly in appearance and length obtainable. They gave fairly good spectra in a small direct-vision spectroscope. The shock on holding the fingers near the terminals is unpleasantly strong. At a low speed, no shock is felt when the terminals are held firmly. A telephone connected to the brushes also gives scarcely any sound, unless a spark gap is interposed.

Various experiments have been tried with the machine discharging through a spark gap and the thick wire circuit of an induction coil of few turns with oil insulation. In this coil there are 10½ turns of copper wire 2·5 mm. diameter, forming a helix of 5 cm. inside diameter and 8·5 cm. long, and 116 turns of wire ·2 mm. diameter, forming a helix about 3·9 cm. diameter. The sparks from the secondary are about ·5 cm. long. They appear similar to those from a good ordinary induction coil, but they give almost no shock when allowed to pass to metal balls held in the hands. When taken directly on the fingers they produce a strong burning sensation. Vacuum tubes connected to the secondary terminals are very brilliantly lighted, the tubes appearing entirely filled with light, and the common glass of the tubes showing green phosphorescence. A Swan lamp held in the hand, with its wires in contact with one of the terminals, gives the same results, and the lamp feels perceptibly warm; this may be only due to electric discharge through the skin. A common vacuum tube, with a thin helical tube and terminals 10·5 cm. apart, connected at both ends to one secondary terminal, lights at the ends, the middle remaining dark. On approaching another vacuum tube, without terminal wires, to the middle of the first tube, both tubes light continuously, the second tube being held in the hand. Feeble effects were obtained from the secondary even when no visible sparks passed at the primary spark-gap; presumably the capacity of the connecting wires and other parts of the apparatus is sufficient to cause this result. No result was obtainable when the alternator was connected directly to the coil, without a spark-gap.

In view of the small output of this machine, I have not thought it worth while to attempt to measure it, or the efficiency. There would probably be no particular difficulty in measuring the output with idiostatic electrometers and liquid resistances; an electrodynamometer, even if it could be made sufficiently sensitive to measure the current, and insulated sufficiently to prevent cross-sparking, would probably be rendered useless by electrostatic forces. Thomson electrometers would probably be suitable, but their cost prohibits their use for experiments of this kind, in which there is no prospect of immediate profit.

The present machine does not appear to be of much use. Apparently the chief hope of making a useful machine lies in increasing its working difference of potential and frequency. The increase of potential necessitates better insulation between the sectors than a surface open to the air, and I have hopes of being able to improve this by covering the spaces and edges of the sectors with a flexible cement, and with sheet India-rubber. Other methods of interposing insulation between the sectors are obvious. The frequency might also be increased. I have not driven my present machine much beyond 900 revolutions per minute, but it would probably be safe at 1,800, corresponding to 600 ∿ per second. The possible frequency obtainable by any such machine depends on the tenacity of the armature disc or drum, and the width of the sectors and insulation. Assuming that an armature could be made to hold together with a peripheral speed of about 500 feet or 15,000 centimetres per second, and that each sector and its insulation occupied ·2 cm. on the periphery of a drum, the frequency would be 37,500 ∿ per second. The field inductors might conceivably be driven in the opposite direction at the same speed, giving 75,000 ∿ per second as the maximum attainable. This is not so great as to repay the work that would be required to design and make such a machine, even if it were practically possible to do so.

Descending from these heights to the immediately practicable, it appears that an interesting machine might be made with a disc or discs 24 or 30 inches in diameter, allowing wide insulating spaces, such as 10 cm., and not attempting to go beyond 100 ∿ per second, so that a smaller number of insulating spaces would be necessary. Several defects have appeared in the present machine. The chief of these is the bending in of the glass plates so as to touch the disc, when the circuit of the alternator is closed. This would probably be remedied if the plates were held all along their edges, instead of at the sides only, but ebonite supports might be added near the centre. The tendency of the field plates to get overcharged and then discharge completely by sparking, is also troublesome, and necessitates turning the exciting machine by hand, judging the amount necessary by watching the discharge of the alternator. It would be possible to overcome this difficulty by using a continuously driven exciting machine, so small as to be unable to charge the plates to sparking point; or a gauge electroscope might be arranged to break contact with the exciter when the P.D. of the field sectors reached a certain point, as used in connection with the Thomson replenisher. It may be noted that if a pair of stationary brushes were arranged to touch two successive armature sectors on the edge of the disc or elsewhere, a one-direction discharge could be obtained from them, and used to charge the field plates, the machine in fact becoming the first form of influence machine described by Holtz. Another defect is that the brushes do not last very long.

When the rotating sectors are charged to act as field inductors, and the alternating current is taken from the fixed sectors, the machine described above gives considerably shorter sparks (about ⅓rd mm.); the inner surfaces of the glass plates probably act to some extent to shield the fixed sectors. But a machine specially arranged for this purpose might have advantages. The revolving sectors might be plates completely covered with insulation, and the stationary sectors arranged on the inner surfaces of their supports, which could then be made stiff and strong. The slight supply of electricity necessary for the field might be supplied from fixed points, without brushes, and loss by sparking at terminal brushes would be avoided.

A modification would consist in making both the field and armature sectors stationary, and using moving unconnected sectors to vary their relative capacity. There appears to be no advantage, and considerable disadvantage, in this arrangement. I have tried the above described machine in this way, but obtained no result, the sectors on the disc being so close together that no variation actually occurs.

LONDON ELECTRIC RAILWAYS.

THE GREAT NORTHERN AND CITY ELECTRIC RAILWAY.

THE Select Committee appointed to consider the proposal to construct a number of underground railways, to be worked by electrical or cable motors, resumed sittings at the House of Commons on Thursday, Sir John Kennaway, Bart., presiding. The case of the Waterloo and Baker Street Railway was disposed of at the last sitting, and the scheme now taken up was that of the Great Northern and City Extension, to run from Moorgate Street to Finsbury Park.

Mr. CRIPPS, Q.C., on behalf of the promoters, opened the case, saying they wished to construct a line three miles long in 16-feet tubes at a cost of £1,200,000, exclusive of an outlay of £200,000 on equipment. They anticipated that the line would earn a dividend of at least 4 per cent. on the outlay, and Sir Henry Oakley thought that could be done without in any way interfering with the traffic receipts of the North London or the Metropolitan Railway. The North London, being satisfied of that, were not there that day to oppose, and he should be able to satisfy the committee that the Metropolitan also had nothing to fear. There was an enormous omnibus traffic between Moorgate Street and Finsbury, the route seeking development, and the Great Northern Railway had a traffic of about £30,000 a year requiring an outlet. Practically, the only opponents of the proposed line came forward on the principle of competition, alleging that were the railway built it would injure them.

Sir DOUGLAS FOX, C.E., said he was joint engineer with Mr. Greathead in the present matter. They had satisfied themselves that the traffic was in a constantly congested state along the line of the proposed railway, and they had laid out the route in order to relieve that congestion. The Great Northern Railway were willing to exchange traffic with them at their junction with that line. From Drayton Park, Old Street, and Essex Road, there would be very great traffic out into the suburbs. The Great Northern had a splendid and unequalled suburban district. This line had been received with open arms by all the local authorities, and there was very little opposition of any kind. The estimate was £1,200,000 for construction, to which had to be added a sum of £250,000 for lifts and electric installation, which would be placed close to the Drayton Park Station, away from all houses, and where it could not be a nuisance to anyone. The total length of the line would be about three miles, and the steepest gradient would be as 1 in 45. He estimated that the company would run some 250 trains per day each way, and that it would earn about 5*s.* per train mile, as against 6*s.* per train mile earned on the Metropolitan.

In answer to Mr. RICKARDS, who opposed on behalf of the Metropolitan Tramways Company,

Sir DOUGLAS said the line would give the same facilities for traffic to workmen and business men as were given by the Great Northern Railway. At present, the Great Northern trains running into the city were much crowded. Trains brought into the city as far as Drayton Park, by the ordinary steam engines would be connected with and taken on by electrical engines. This was not in the nature of an experiment. It was done in other countries and could be carried out here just as easily. The electrical engine would take forward a full suburban train, carrying 500 passengers, and weighing 150 tons. It would need a little larger and stronger electrical locomotive than usual, that was all. Witness was engineer of similar railways at Liverpool, where they carried 10,000,000 of passengers a year, one of their lifts going down 100 feet below the pavement. The City and South London line ran under the proposed railway. The working expenses would be 50 per cent. of the receipts. They wished to take capital powers for £2,000,000. He himself did not know of an electrical line, the working expenses of which were so low, but Mr. Siemens, who would be called, might know of one. It was not pretended that the line would give communication between the north and south side of the river. He did not think they would spend anything like the whole of their capital. The tunnels would be 16 feet in diameter.

Messrs. BROWN, who had opposed, here stated, through counsel, that having obtained what they wanted, they withdrew their opposition to the scheme.

Sir D. FOX, in answer to Mr. WORSLEY-TAYLOR, Q.C., said that the Great Northern Company were in favour of the line, and that it was arranged that they should use the railway as far as Moorgate Street, with their ordinary trains. The 16 feet tubes were a *sine quâ non*, with the Great Northern, and intended to meet the needs of their main line trains. He thought figures given in the estimate were fair and reasonable.

Mr. THOS. FRAZER BLACK, residing at Stroud Green, and in business in the city, was called to speak to the necessity for the proposed line. He said many people did not go to Moorgate Street from Finsbury Park merely because the trains were too crowded. He had travelled with 19 passengers in one first-class compartment. (Laughter.) It was a common thing for passengers to hold the handle inside to keep others from entering the carriage. There was a strong feeling on the matter in his vicinity, many residents had left the neighbourhood, and some had petitioned the Midland and other companies to come to their assistance. He could get from Tunbridge Wells to Cannon Street quicker than from Stroud Green to Moorgate Street.

By Mr. POPE: Changes in suburban or short distance traffic are objectionable always, but more especially when the train you have to get into is already full.

Mr. JOHN IMRAY, examined by Mr. CRIPPS, said that till six months ago, and for 15 years, he lived near Finsbury Park, and found the trains so unpunctual and crowded that he had to come into the city to reside. He sent in a bill to the company for loss of time (laughter), but the bill was not paid. He could not get to Farringdon Street in time; that was why he came into the City to live.

Mr. JAMES HATTON BARBER said he came before the committee under the direction of the Islington Vestry, to state that the proposed line would be a great convenience to that district. Several petitions had been received by the vestry from the inhabitants of Drayton Park, and other parts, asking them to approach the Great Northern Company with a view to getting a new line made into the City. He thought the traffic along the route proposed was sufficient for the existing means of transit as well as to feed the new railway.

Mr. ALEX. SIEMENS said the reason the larger electrical locomotives had not yet been made was that every industry developed, and that this was only in course of development. He thought electricity could pay in a case of this kind merely when the trains were run very frequently. Electrical power would be cheaper than steam if the trains were very numerous. He thought that on the Baltimore and Ohio Railway there was a case in which electricity was used—as intended to be used here—for moving full-sized trains. That was an experimental piece of 4 miles, including a tunnel under a river; but there was no case on all fours with this. He had no doubt in his own mind that it could be done—that electricity would be sufficient as a motor for the entire needs of the railway proposed.

Sir HY. OAKLEY said he was general manager of the Great Northern Railway, and that this scheme was brought before him first in October last, when the promoters were told that the Great Northern could not countenance it in its then form; but that they might if it were enlarged so as to be able to accommodate the Great Northern rolling stock, and if they could satisfy him that they could work it with electricity. The promoters answered that they could. He then laid the matter before his directors, who authorised him to promise that if the electrical locomotives would pull a train of eleven full-sized Great Northern coaches, filled with passengers, and if the tubes were large enough, the company, instead of opposing, would support and use the line. It was shown that there was no doubt whatever that the electrical power would be sufficient for the purpose. As originally proposed, the line was to see daylight, not at the present terminus, but at Finsbury Park, but he suggested Drayton Park. The problem how to get Great Northern passengers to the City had been one of the chief troubles of his life for many years. Witness here detailed the efforts made by his company since 1874 to get into the City, noticing also what had been done by the Midland, the South-Eastern, and other lines to the same end. Some years ago they were utterly unable to cope with the suburban traffic along their lines, and their season ticket-holders and others literally revolted. After that his company obtained other entrances into the City, by which means, until about a year ago, they managed the traffic pretty well. For a year or more, however, the congestion on their lines had been very bad, and it was rapidly increasing. His directors hoped that the present scheme would be useful, and give the needed relief. The traffic the Great Northern had to deal with increased practically 10 per cent. per annum. In 1883 their suburban traffic was 4,000,000 of passengers, which included all districts, King's Cross, City, across the water, and North London traffic; in 1886 it was 17,000,000, and in 1891 22,000,000. In 1874 they paid the Metropolitan for the use of its lines £14,425. Last year it was £24,416, exclusive of rents paid under agreements for use of Moorgate Street Station, King's Cross Station, and other underground stations. The greater the certainty and enlargement in the means of transit the more rapidly did the demand for those means increase. The proposed line would doubtless take its fair share of work. It would probably run 250 or 300 trains per day each way, and earn 4*s.* 6*d.* or 5*s.* per train mile. It would certainly be much appreciated in its own district, and its traffic would be entirely separate from that of other lines. The promoters could pay £450,000 or £500,000 for the construction of the line, but if they could make it for less they would have a better chance of making money. (Laughter.) The schemes that witness had previously had brought to his notice were costly in the extreme—something like a million per mile. To get anything like a good station in the city three millions would only look at it. The present was a very good scheme, the best he had ever seen to meet the case. At £400,000 per mile it would be quite practicable. It was out of the question to make an ordinary railway through the city. It would cost too much, owing to the value of the property to be taken. When they took a house for such a purpose they took a man's trade too, and it was astonishing what good trades they were when you came to disturb them for a railway. (Laughter.) The crush on the Great Northern suburban lines was now so great that the officials were powerless to keep the different classes of passengers to their own carriages, and the trouble was increasing. This question of dealing with the suburban traffic of London was one of the burdens of his life. If this line were sanctioned and made it would be a great relief, and would not cause interference with any agreement between the Great Northern and the Metropolitan, or he would not be there. Anything that improved communication north and south was beneficial to the Great Northern as well as to other railways. He denied that he had the power to fix the times of his trains on the Metropolitan.

Mr. LITTLER examined Sir Henry Oakley on his agreements with the Metropolitan Company. WITNESS said that under these agreements the Metropolitan had prospered far "beyond the dreams of avarice." (Laughter.) He would not give up any of these agreements, however. He desired the use of the line for the benefit of his passengers. What the Metropolitan got from the Great Northern must be more than 1*d.* a passenger, the total being about £35,000 a year. In 1875 the Great Northern season ticket-holders and others rebelled in consequence of the want of facilities. Owing to the great and increasing pressure they had increased their daily passenger trains in and out of Moorgate from 122 to 152. It was not correct to say that the present Metropolitan lines were sufficient to deal with

the traffic. Looking at the time tables he must say that the Metropolitan lines were crowded. Practically as many trains as could be run were now run on them.

Mr. LITTLER said his clients (the Metropolitan) maintained that they could run double the present number of trains over their lines if only the Great Northern would be punctual with their trains and thus allow them to do so.

Sir H. OAKLEY, in answer to Mr. Pope, Q.C., said the Great Northern were giving the new line no money: nor were they entering into any guarantee with it—it was a pure question of interchange of traffic between the two companies. They would through-book on the principle of mileage division.

Mr. CRIPPS said that was the case for the promoters.

Mr. LITTLER said an essential point of the preamble had not been dealt with. It had not been shown how the money was to be obtained. He would like to know why the promoters had not been called.

Mr. CRIPPS: I have closed my case.

Mr. LITTLER, having in vain called the promoters, asked for a Speaker's order to secure their presence on Friday morning. The persons he wanted were Baron Camoys and Messrs. F. R. Stonor, Roger Richards, Daniel Bayley, and John H. Borrer.

The committee refused the application.

Mr. JOHN BELL, manager of the Metropolitan Railway, said the proposed line would of necessity divert traffic from his line. The Metropolitan were under an agreement with the Great Northern which they would be glad to give up. It would not be fair to reduce the amount which his line derived from Great Northern traffic, and he thought that sum ought to be guaranteed to his company if this proposed new line passed. He entirely dissented from Sir H. Oakley's statement that the Metropolitan lines were crowded. The trouble was that the Great Northern trains did not run regularly, otherwise 20 trains an hour might be run—one in every three minutes. Over and over again he had told Sir Henry Oakley how the Great Northern could run many more trains over the Metropolitan lines, but, except on rare occasions, Sir Henry had done nothing in response.

The CHAIRMAN intimated that what did not reach the House of Lords by Monday would have no chance to go forward in this Parliament, and he did not understand, so far as his information then went, that any advantage would be gained by going on with Bills that could not pass the Commons before Monday. He hoped this Bill would be finished on Friday. All Bills left over to the new Parliament would be in the same position then as now. If the committee took up another Bill on Friday, it would be that of the Hampstead line.

The committee adjourned till Friday.

Upon resuming on Friday, Sir JOHN KENNAWAY, Bart., presiding, the chairman said he understood that the opponents maintained that the Great Northern and City actually was a Great Northern Bill?

Mr. WORSLEY-TAYLOR: Yes, certainly.

The CHAIRMAN: But they would have to go to Parliament before they could take it over for the benefit of the Great Northern?

Mr. CRIPPS: Yes, of course.

Mr. W. TAYLOR: Yes, if they took it over bodily; but it will not be done in that way.

Mr. BELL, manager of the Metropolitan Railway, resuming his evidence, said if the Great Northern were to run their trains as regularly as they ought it would make a great difference in the receipts of his line. His directors had tried to make arrangements for electrical experiments, to see if their railway could be worked in that way, offering electricians very favourable terms, but, so far, in vain. Omnibuses and trams were put on overhead along the route of the Metropolitan Railway, which seriously affected the traffic on the latter. When the Walham Green omnibuses were put on from King's Cross, they affected their receipts to the extent of more than £200 per week. There was no comparison between the Metropolitan railway and the one now proposed to be constructed. Last year, the Great Northern carried from Finsbury Park over the lines to King's Cross, Farringdon Street, Aldersgate Street, and Moorgate Street, about 2,000,000 passengers; in addition, there were the season ticket-holders, calculated at six trips per week, 5,200,000—over 7,000,000 journeys.

The CHAIRMAN: We may take it that they now carry over your lines 7,000,000 passengers a year?

WITNESS: Yes, and the proportion we got for that was £22,778 last year; that was our share—a penny a passenger, as I said yesterday. This new line, to earn 4 per cent. on its outlay, would require to carry 25,000,000 passengers a year, at 1½d. per head, which is a higher figure than they would be likely to reach for years. There are other Great Northern passengers carried on other parts of our lines.

Mr. CRIPPS: Yes; we have 22,000,000 of such passengers a year, as Sir Henry Oakley said yesterday.

WITNESS: My figures are on the supposition that the working expenses of the new line will be only 50 per cent. of the receipts; that is a very low estimate. The total number of passengers we carry is about 90,000,000 per annum. Taking the seating capacity of the Great Northern city trains, and only 29 per cent. is occupied, as a rule. We can give the Great Northern 50 per cent. more accommodation than they now utilise on our lines. It has taken us many years to build up our traffic, and the new line would have to wait till it could build up one for itself; but it would do us much harm, and we ought to be protected from injury.

Sir EDWARD WATKIN, Bart, M.P., examined by Mr. LITTLER, said he had been chairman of the Metropolitan railway since 1882. He had fully considered this Bill, and was opposed to it, as the line would interfere seriously with the Metropolitan interests. The great cause of trouble in the traffic was that the Great Northern would not arrange a scientific time table, and run the maximum number of trains. They at present ran at very unequal intervals, but where the traffic was so very great it should not be so. With a scientific time table, such as Colonel Bell had prepared, the whole of the suburban traffic could be dealt with without difficulty. The Metropolitan worked all its traffic without any difficulty. It was only when people came in who did not know how to work a railway that difficulty was felt. (A laugh.) All that was wanted was the exhibition of a little more common sense on the part of the Great Northern. Everybody wanted to get into the City at about the same time, and unless the trains were run to time, and in a scientific way, there would be trouble. There were "bogus" time-tables, on which were marked trains never intended to be run. The Great Northern, he believed, was the greatest offender in this direction. The "bogus" time table was to keep other companies from using the line. He had told Sir Hy. Oakley more than once, on the receipt of complaints from the Great Northern, "If you don't like the accommodation you get from the Metropolitan, you can give up your agreement with us." Practically, the Great Northern run as many trains as they liked over the Metropolitan. They could get all the accommodation they desired. Before the Metropolitan line was opened there was no such thing as residential traffic on the Great Northern. It was a new thing. Any interference that had taken place in regard to Great Northern traffic was entirely their own fault. The Great Northern had no cause to complain of want of accommodation.

The CHAIRMAN: Then you are not in favour of competition?

Sir E. WATKIN: Oh, yes; I am in favour of competition, but it should be honest competition.

Mr. LITTLER, Q.C., next addressed the committee for the Metropolitan Company, who opposed, saying that the Great Northern Railway, who were warmly supporting this Bill with the object of ultimately taking over the line, were under an agreement to use the Metropolitan lines, which they were not doing as fully as they might, whilst Sir H. Oakley had refused to give a guarantee that he would continue running even the present number of trains over those lines. If the Great Northern wanted to get into the City by another route, let them come openly and say so, and ask Parliament for power to do so, then it could be fought out fairly and squarely on its merits. The Metropolitan would infinitely prefer that the Great Northern should drop the agreement to use their lines. It was clear that this was a line either to be hawked about or to extract money from the Metropolitan. The absence of the promoters showed that the line was backed by nobody unless it were the Great Northern. The City and South London Electric Railway was a lamentable and miserable failure, as he predicted this would be if it were ever built.

Mr. W. H. HAMMOND, secretary of the Metropolitan Tramway Company, said the capital of that concern was £1,402,500, and that the mileage of track in use was 49, which gave a capital of £28,600 per mile. Last year they carried 75,370,000 passengers, their earnings being—gross, £430,000; net, £94,812. The proposed line would seriously compete with the business of his company. The seating capacity of each tram was 48, and the average number of passengers carried per tram mile 10.

Mr. POPE, Q.C., who opposed on behalf of the Tramway Company, said the present was the first electrical proposal brought forward to deal with passenger traffic that was not a mere sewer proposal, but it would not be right to sanction a speculation of the kind. The Great Northern did not support the scheme, except by a letter which said they would exchange traffic with it "if the promoters showed by practical operations that the line could be made and successfully worked" by electric motor. There was not an inch of the line that would not be in competition with the tramway company—it was for local as well as general competition. As an experiment in electrical science the line ought to be tried elsewhere, and not where it would seriously hamper already authorised and existing means of transit. Parliament had placed upon the tramway company an obligation to spend a very large sum annually on the maintenance of roadway, but this new line, being below the surface, would have no such obligation placed upon it. If the Great Northern were not at the back of the line, who was to find the money? It was a marvellous thing to him that not one of the promoters had thought fit to come forward and explain how the money was to be raised. It was a taking idea that the Great Northern traffic was to be carried forward by means of electricity, but if they were to go beyond the idea and form the promoters into a company, it should be shown how the project was to be realised.

Mr. CRIPPS, replying on behalf of the promoters, said he wished to show the inconsistency between the positions of Mr. Littler and that of Mr. Pope. The opposition came from rival carriers only, while the City authorities, the Islington vestry, and other public bodies, favoured the scheme as being the best brought forward, so far.

The committee came to the opinion that the preamble of the Bill had been proved.

The clauses were then dealt with, and the Bill was ordered to be reported in the usual way.

In view of the impending dissolution, it was decided to let the other four lines lie over till after the election.

LONDON COUNTY COUNCIL.

AT the usual weekly meeting last Tuesday week, the following were submitted:—

London County Council (Subways) Bill.

The Select Committee of the House of Lords on this Bill decided to omit the provisions of it relative to the electric lighting companies,

or in the alternative to provide that all the bye-laws for regulating the subways should be made by the Board of Trade instead of by the council. After discussing the matter with our chairman, with the deputy chairman, and other members of the council, the agent came to the conclusion that the better course would be to omit the provisions of the Bill relative to the electric lighting companies. As regards the electric lighting companies, there is no doubt that the council has at present ample powers, but, as was explained to the committee, the reason for including them in the Bill was merely the assumption that advantage would result from uniformity of legislation. We recommend that the course taken by the agent in omitting from the Bill the provisions relating to electric lighting companies be approved.

Electric and Cable Railways (Metropolis).

In accordance with the resolutions of the council we submitted the views of the council on this matter to the joint committee of both Houses of Parliament, and supported the same by the evidence of the agent, the engineer, the chairman of this committee, and the chairman of the Housing committee. The chairman of the Parliamentary committee of the London County Council was requested by the joint committee to submit a memorandum, and the following memorandum was accordingly submitted to the joint committee of Lords and Commons—

It may be desirable to explain that, in suggesting certain amendments to safeguard the public interest, the council has no wish to take up a position hostile to the promoters of the Bills now under consideration by the committee. The council is, on the contrary, impressed with the great importance of providing London with additional means of internal communication, and its only desire is that all the various schemes should, in the interest of London's future growth, be dealt with upon broad general principles, so as to make the lines as useful as possible to the public, not only of this but also of future generations. It must be borne in mind that, once any of these lines is constructed, it will be for many years practically impossible to construct any other along the same route; nor can the tunnels, once made, be afterwards enlarged, except at an enormous cost. It is therefore inevitable that the proposals of the promoters should be closely scrutinised, as involving the deprivation of the people along that route of the possibility of an alternative service.

The questions now to be decided will go far to establish the principles which will be followed in all future cases, and affect not the present proposals alone, but all future electric lines.

Uniformity of Tunnelling.—The first point urged by the council is that the size of the tunnels should be uniform for all the London lines. It will be unnecessary to dwell upon the desirability of insisting that the lines should be so constructed as to permit of interchange of traffic *with each other*. Without uniformity of tunnel, uniformity of gauge may easily become of no use. It is impossible at present to foresee exactly what form of rolling stock may be found most convenient for this new class of railway, and no one line ought to be allowed to adopt a dimension of tunnel which may be found hereafter to hamper the full development of London's internal communication, as seriously as the old "Battle of the Gauges," hampered English railway development. At present the Bills before the committee propose three different dimensions of tunnel, viz., 11 feet 6 inches, 12 feet, and 16 feet. It is submitted that a uniform tunnel dimension should be determined on by the committee.

Connection with Existing Railways.—If the committee decide upon a uniform tunnel dimension, the council urges the importance of so constructing the lines as to leave open the possibility at some future time of interchange of traffic with the existing railways serving the suburban belt. The value of this interchange is recognised by one of the Bills before the committee, viz., the Great Northern and City Railway, which includes proposals for connection with the Great Northern Railway Company near Finsbury Park, and of which the tunnel is accordingly to be 16 feet in diameter.

In connection with its work relating to the housing of the poor, the council is impressed with the absolute necessity for facilitating a greater spreading of the population. It is of vital importance to the future well-being of London that every possible opportunity should be taken to promote cheap and rapid communication between every part of inner London and what is at present the outer suburban belt. The council would regard it as a serious calamity to London if the proposed lines were so constructed as absolutely to preclude their forming easy connections with the suburban lines of railway at some future time.

In support of this contention the experience of the Metropolitan and Metropolitan District Railways may be alluded to. Intended originally only as "circle" lines, they have both found it expedient to stretch out into the suburban belt, in order to accommodate the traffic caused by London's constant expansion.

It may very possibly be found equally necessary for the full success of the electric railways that they should possess direct communication with the outer suburbs, rising gradually to the level of the surface railways at a distance of some miles from central London, as the Great Northern and City Railway already proposes to do near Finsbury Park. The possibility of mutual running powers ought therefore not to be precluded.

It has been urged that this object is secured so far as it is practicable by the uniformity of gauge, which would permit the light carriages of the electric lines to run on the present railways, although the rolling stock of the latter would not be able to enter the deep and narrow tunnels. But it is felt that such an arrangement might easily prove illusory. It must be doubtful whether trains of the peculiar pattern contemplated by the promoters (other than those of the Great Northern and City Railway), could in practice safely be run amid the crush of morning and evening traffic on the existing lines.

It has been urged that ordinary steam locomotives could not be worked at the great depth proposed. But even if this must always be the case, the possibility of electric locomotives being used on the existing railway lines may, at any rate, not be absolutely excluded from consideration. The form and size of the rolling stock contemplated by the promoters can scarcely be regarded as other than experimental. No one would assert that the style of omnibus carriage at present in use is entirely satisfactory. The promoters might fairly be required, in the interests of the public, to leave open the possibility of adopting the dimensions actually suggested by one of them, viz., the Great Northern and City Railway. Already in the short history of electric railways has there been a marked tendency to increase the dimensions of the tunnel. The tunnel first proposed for the City and South London Railway was only 9 ft. 6 ins. This was altered to 10 ft. The Central London Railway Act of 1891 contemplated a tunnel of 11 ft. 6 ins., which is the size now desired by the City and South London Railway Company for their Islington extension. The Baker Street and Waterloo Railway Bill seeks power for a 12-ft. tunnel, which is also the dimensions desired for the Waterloo and City Railway. Finally the Great Northern and City Railway Bill proposes, as has been already mentioned, a tunnel of 16 ft.

In this experimental stage of the invention, and with the actual tendency to expansion already indicated, to make the standard tunnel dimension 11 ft. 6 or 12 ft. only, would seriously hamper the possibilities of improvement. A 16-ft. tunnel would not prevent the use of 11 ft. rolling stock should this hereafter be found the most convenient size. But a 12-ft. tunnel might absolutely prevent the adoption of a whole host of what were found to be desirable improvements.

The committee is therefore asked to adopt the proposal of the Great Northern and City Railway Bill, viz., 16 ft., as the standard tunnel dimension for all electric railways within the London area.

Construction from point to point.—The next question which the council asked the committee to determine is the general direction of the lines. It is for the interest of the public that the shortest and most direct routes should be followed in all cases. Surface railways, and those constructed on the "cut and cover" principle, are necessarily forced to depart from these routes, in order to avoid valuable property. But at the great depth proposed, this consideration becomes less material, as all that need be granted is what is virtually an "easement of tunnelling," with an obligation to pay for actual damage only. But in order to avoid even this compensation (or still more, the legal questions that might be raised if no explicit declaration is inserted in the Bills), the promoters propose to turn and twist their lines so as to follow the direction of main streets. And as the public authority has, in most instances, no actual freehold in the streets, it is contemplated that no claim can be made by it upon the promoters.

It is, however, submitted that considerations of this kind should not be allowed to interfere with the best possible planning of the lines in the public interest. It is highly objectionable that the assumed lack of power in the public authority to claim the same compensation for damages as a private freeholder, should further militate against the public interests by encouraging an unnecessarily lengthy and tortuous construction of the lines.

It has been admitted by the engineer to the promoters that if the lines could pass under houses without any greater cost than under streets, it would be desirable, in order to avoid unnecessary curves, to do so.

The council accordingly suggests that the lines should, wherever physically possible, be made direct from point to point, and that an "easement or right of tunnelling" should be established, carrying with it the obligation to pay only for actual damage, and that, in this respect, the public authority should be placed, as regards the streets, upon the footing of a private freeholder, where no other freeholder can show title.

Power to purchase.—A further principle, which the council urges the committee to adopt, is the grant of power to it, as the local authority, to purchase the lines, in a manner similar to that laid down for tramways and electric lighting works. It may be observed that it is not proposed that the lines should, in any sense, "revert" to the local authority without payment (as is the case with foreign concessions), but merely that the local authority should have compulsory power to purchase, on fair terms, after the expiration of a reasonable period. A compulsory power to purchase is given, in the case of all English railways, by the Act of 1844, to the National Government. But it is urged that as the lines now proposed are in many respects more akin to tramway than to railway lines, the more recent precedents of the Tramways Act should be followed, due modification being made for the greater cost of the works.

In the absence of any new principle, it will perhaps be assumed that the Act of 1844 would apply to the proposed electric railways. But if only to avoid such litigation as that which ensued upon the desire of the Postmaster-General to apply to the telephones the provisions of the Telegraph Act, it is desirable that it should be clearly laid down whether the proposed electric railways are to be deemed to be included in the Act of 1844.

To the compulsory power of purchase, which would in that case be given to the National Government, the council desires to offer no objection. But whether or not, these electric lines are, for that purpose, to be treated as railways, the council would strongly urge that their close analogy to tramways should also be considered. They are essentially local in their character, and the council would suggest that, whatever power to purchase is given to the National Government (which is in the highest degree unlikely ever to exercise it), power of purchase should also be given to the local authority upon the principle adopted in the cases of tramways and electric lighting works.

In support of this contention, the council would urge that the electric railways are avowedly intended merely as a substitute for tramway locomotion, and that the promoters resist any obligation to undertake the additional services (such as goods traffic, conveyance of cattle, minerals, &c.) performed by ordinary railways.

The position of the local authority with regard to them is very analogous to its position with regard to tramway companies. In the latter case the promoters seek power to use the surface of streets, in which the local authority has usually no fee simple, but only easements of various kinds. In the case now under consideration the promoters seek power to occupy not the surface, but the subsoil, in which the local authority equally has extensive easements and of which it, in certain cases, possesses the freehold.

It is submitted that a valuable privilege is sought by the promoters; that it is not proposed by them to make any payment to any public authority in respect of that privilege; that the effect of granting it must necessarily be the creation of a virtual monopoly which cannot fail seriously to affect the public interest; and that it is extremely undesirable to establish such a monopoly without giving some authority representing the public the legal power to review its conditions, after the lapse of a reasonable time, in order that any future injury to the public may be prevented.

The council is prepared to admit the view that the great cost of the works proposed, and their necessarily experimental character, warrant the grant of a longer period of enjoyment of the monopoly than in the case of the tramways. The period of 21 years, adopted also for electric lighting works, was afterwards enlarged in the case of the latter to 42 years. For electric railways the council has suggested that the period might reasonably be fixed at 60 years, a term beyond the expectation of life of any investor.

The Joint Select Committee of the House of Lords and the House of Commons have now made their report, which we submit in full for purposes of future reference, having regard to the exceptional nature of the works, &c., proposed:—

"1. The committee have met and have considered the matters referred to them, and have taken evidence submitted to them by the promoters of the various schemes, including that of electric and other engineers, as well as that of representatives of the London County Council, of the Corporation of the City of London, of the agent and surveyor of Lord Portman's St. Marylebone estate, and the Board of Trade.

"2. The railway schemes that have been referred for their consideration are the following, viz.:—The Great Northern and City Railway; the Central London Railway; the City and South London Railway; the Waterloo and City Railway; the Baker Street and Waterloo Railway, and the Hampstead, St. Pancras, and Charing Cross Railways.

"3. The committee desire, in their report, to deal separately with the proposed Great Northern and City Railway.

"4. The main objects of this scheme would appear to be to assist and relieve the great and growing local passenger traffic of the Great Northern line, and to afford it a new and direct access to the City.

"5. It appears to the committee that there can be no reason why this scheme should not be considered by committees in ordinary course.

"6. Further, the committee are convinced that direct communication through London for the main railway lines north and south of the Thames, whether for the convenience of their country or their suburban passenger traffic, would be of undeniable utility. And they cannot doubt that the growing needs of those lines will, sooner or later, lead to the construction of one or more of such communication.

"7. But the purposes which the proposed new lines, with the exception of the Great Northern and City Railway, appear intended and adapted to meet, are of a different character.

"8. They are required to relieve the overgrown passenger traffic along the chief thoroughfares, to provide for the natural expansion of London, and to check the congestion of our metropolitan population by facilitating cheap communication outwards to a circumference which tends constantly to recede.

"9. More such lines of communication are required with existing suburbs, and there is growing need of their extension still further into the country, in order to meet the increasing necessity for the removal of portions of the population to a greater distance.

"10. The lines now in question will afford some portion of this much-needed accommodation; and where they terminate in or near the open country, they are practically certain of further extension to meet the needs of a growing and spreading population.

"11. It does not appear to the committee, with regard to any of these lines, that their construction would prevent that of other lines which the necessities of London may from time to time require, and they see no reason, therefore, for advising the postponement of the consideration, in ordinary course, of any of these Bills.

"12. With regard to the question whether underground railways worked by electricity or cable traction are calculated to afford sufficient accommodation for the present and future probable traffic, the committee report that the evidence submitted to them was conclusively in favour of the sufficiency and the special adaptability of electricity as a motive power for the proposed underground tubular railways, whilst the method of cable traction appears also to be of recognised utility, especially in the case of steep gradient lines.

"13. The proposed routes appear to be fairly satisfactory, considered as an instalment of the more complete accommodation necessary to meet the constantly increasing needs of London.

"14. As to the terms and conditions under which the subsoil should be appropriated, the committee report that in the case of private property, not under the public streets, it appears to them to be desirable that the companies should be allowed to acquire a wayleave, instead of purchasing the freehold of the land, subject to the terms of the Lands Clauses Acts as to compensation.

"15. In the case of public streets the committee think it expedient that the companies should be empowered to pass under the streets at sufficient depth without payment of compensation for the wayleave. In consideration of such free passage the committee advise that the companies should be put under obligation to furnish an adequate number of cheap and convenient trains.

"16. The evidence submitted to the committee on the question of the diameter of the underground tubes containing the railways, has been distinctly in favour of a minimum diameter of 11 feet 6 inches.

"17. The committee have directed the minutes of evidence taken before them, together with an appendix, to be reported."

It will be observed that the joint committee have to some degree accepted the suggestions offered by the council. Each of the railway schemes will now go in ordinary course before the Select Committee, which meets on Tuesday next, and we have directed the agent to take the necessary steps to support the allegations in the petition which the council has presented against the Bills. One of the suggestions made in our report on the 10th instant was as to the desirability of powers of purchase of lines being reserved to the council, but this suggestion was not adopted by the joint committee. We consider it important, and Mr. Pickersgill has placed a motion on the votes of the House, by way of instruction to the committee with respect to all the electric lines, that they do insert a clause reserving to the London County Council a power to purchase the undertaking after the expiration of a limited period, on terms similar to those provided in Section 43 of "The Tramways Act, 1870." In the event of the House passing such instruction we have instructed the agent to support the proposal, and all the points raised in the engineer's report and petitions, and recommend that the course taken be approved.

Notices under Electric Lighting Acts and Orders.

We have considered a notice, dated May 13th, 1892, given by Mr. H. Robinson, on behalf of the Vestry of St. Pancras, under the St. Pancras (Middlesex) Electric Lighting Order, 1883, of intention to lay mains for the street lamps in Euston Road from Melton Street to King's Cross. The lamps will be placed, and it is therefore proposed that the mains also shall be laid, in the centre of the road; and to this there appears in the circumstances to be no objection. We recommend that the council do signify its approval of the works referred to in the notice of the Vestry of St. Pancras, dated May 13th 1892, under the provisions of the St. Pancras (Middlesex), Electric Lighting Order, 1883, upon condition that in order to remove any risk from the possibility of the mains coming into contact with the outer covers of the street boxes, a copper band shall be secured to each cover and be connected to the continuous iron pipe in which the mains are laid.

We have also considered a notice, dated May 23rd, 1892, from the Kensington and Knightsbridge Electric Lighting Company, of intention to lay mains in Church Passage. The proposed works are of the usual character, and we recommend that the sanction of the council be given to the works referred to in the notice dated May 23rd, 1892, of the Kensington and Knightsbridge Electric Lighting Company.

We have further to report the receipt of the undermentioned notices, given in accordance with the resolution of the council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid:—

From the House to House Electric Light Supply Company: May 16th, 1892, to 1 and 2, Moreton Terrace; 6, Barkston Gardens. May 23rd, 1892, to 28, Barkston Gardens.

From the Electricity Supply Corporation: May 20th, 1892, to Union Discount Bank, Duncannon Street; 21, Garrick Street.

From the London Electric Supply Corporation: May 23rd, 1892, to 205, Regent Street.

REVIEWS.

Electric Lighting for Marine Engineers: or, How to Light a Ship by the Electric Light, and how to keep the apparatus in order. By SIDNEY F. WALKER. Tower Publishing Company, London.

This work, as stated in the preface, is an attempt to unite the experience the author gained during eight years of seagoing work with that acquired by him during the past eighteen years. Mr. Sidney Walker endeavours to present to marine engineers, in a simple and concise form, the construction and management of electric light plants, so as to enable them to deal with the ordinary difficulties of everyday practice. This task is not an easy one, and it is not fair to judge of the probable degree of success until time has shown the strong and weak points of the book. The various difficulties likely to be met with are illustrated by examples from practice, and many of the special cases are further explained by diagrams. We cannot compliment either the author or the publisher on the "blocks," which are generally mediocre, but at any rate there are plenty of them, and the text is thus made clear. We are glad to see that Mr. Walker does not approve of the single wire system; this entails an increase of risk without any real compensating advantage beyond a slight decrease in the initial expenditure. We think the author might have made a stronger reference to the possible interference with the compass readings. This is of the utmost importance on board ship, and no compass should be adjusted except with the electric lighting plant

both running and stopped for all positions of the ship during the test. If a second edition of the book be required, this should be attended to. In the eighth chapter the application of electricity to petroleum ships is specially discussed, and the dangers of the single wire system are made prominent. It is with such cargoes that the advantages of the electric light are most apparent, and we hope to see the day when oil lamps will be the exception and not the rule. The electric light, is specially adapted for use in coal bunkers and other confined spaces, which may contain inflammable gases; and its suitability and safety cannot be too widely known. If Mr. Sydney Walker's little book serves to popularise the electric light aboard ships, it will do a good work—we wish it success.

Dynamo-Electric Machinery. By SILVANUS P. THOMPSON, D.Sc., B.A. (Fourth edition.) E. and F. N. Spon, London, 1892.

Four eventful years have elapsed since the third edition of Prof. Thompson's book, and the subject of dynamo-electric machinery has made enormous strides during that period. The development of public electric lighting has necessitated the construction of dynamos of unprecedented sizes, and the battle of high *versus* low tension for central station lighting has given birth to a variety of improvements in machine design, and certain types have become established as best conforming to the requirements of such work. Alternate and direct current distribution of light and power have both made great progress, and the limits of each have been defined to a large extent; and the theory of dynamo design has been brought to a high pitch of perfection by the contributions of Esson, Swinburne and others, to the magnetic theory of the Hopkinsons. Indeed, these past four years have practically brought the art of building dynamo-electric machinery out of the region of empirics, and placed it on a sound basis, both as regards mathematical theory and mechanical construction. Electrical engineering has been recognised as a branch of civil engineering, and holds the high position it is entitled to from its undoubted usefulness to man.

The fourth edition of "Dynamo-Electric Machinery" is, as may be expected, largely a *resumé* of this advance. It is in touch with the workshop and the college, and though professedly only a student's manual, yet will be invaluable to the practical engineer as well as the theorist. It has faults, that goes without saying, but these are chiefly inherent to text books treating on subjects of such rapid growth as electrical technics. The most apparent is the bulk of the volume, and though an evident attempt has been made to make it as complete as possible, it is at places scrappy; and some important machines are so incidentally mentioned as to serve no useful purpose, while others of less moment to the present time are described in too much detail. The only remedy seems to be the division of the whole into two volumes; one, perhaps, confined to general principles, machine design, and perhaps historical notes, although we doubt the utility of the latter; and the other descriptive of modern machines. We hope to find the fifth edition divided somewhat on these lines into two handy volumes.

Comparing the fourth with the third edition, we are at once struck with several important alterations in the arrangement of the chapters and their contents. Indeed, almost the whole book seems to have been re-arranged with advantage, and to a great extent re-written. Electric and magnetic units are very properly treated in an appendix, instead of following pell-mell on the historical notes; and the eleven appendices in the third edition have now been either omitted or the subject incorporated in suitable places in the main text. There are now 29 chapters, several of which are entirely new; and at the end of the volume are 29 well delineated plates illustrative of some of the best modern machines. These latter are drawn to scale, and form a most valuable addition to the book.

In the introductory chapter the reversibility of the dynamo is at once stated by definition, and the four main classes of machines are given as (*a*) direct current dynamos; (*b*) alternate current dynamos; (*c*) direct current motors; and (*d*) alternate current motors. The functions of the field magnet and the armature are clearly expressed, and the three methods of dealing with the principles of dynamos are enumerated: (1) the physical method, dealing with lines of force—the common and most convenient manner of treating dynamo design; (2) the algebraical method, founded upon the mathematical laws of electric induction; and (3) a graphical method, based upon the characteristic curves devised by the Hopkinsons, Frolich, Deprez, and others—this latter being largely used in conjunction with the lines of force method.

Chapter II. contains historical notes, interesting in their way, but so often reproduced as to be tedious; they might with profit be omitted.

Chapter III. deals with the physical theory of the dynamo. An electric current is defined, as regards the magnetic phenomena attending it, the elementary and essential organs of a dynamo are enumerated, and the fundamental equation connecting the E.M.F. with speed, number of turns, and magnetic flux is then given for both direct and alternate current machines. In the equation for the latter, the limiting values of the constant are stated to depend on the relative breadths of the coils and pole pieces employed. The methods of exciting the fields are next discussed. We note that our criticism of Dr. Isenbeck's antiquated apparatus in the review of the third edition, has been productive of good results, and the obsolete description no longer occupies useful space.

Chapter IV. treats of armature actions and reactions, and is very well arranged. It contains clear and concise statements of the general principles, points out difficulties and how to meet them. Fig. 68, which shows the act of commutation of a section of a dynamo armature is an addition to the book and pictorially represents the actual state of affairs. It will commend itself to students.

Figs. 61, 62, 63, and 69 are taken from Esson's paper, "Some Points in Dynamo Design," and are a decided improvement on the old blocks for demonstrating the cross-field and the demagnetising turns.

The chief effect of the cross field is shown to be an increase in the saturation of the pole pieces, and so probably a weakening of the main field, an effect noticed by many observers; and the demagnetising turns are shown to be proportional to twice the number of turns included by the lead into half the current. A good name for these is the *negative ampère turns*.

Self-induction and eddy current losses are also clearly discussed. The lamination of the armature core is insisted on, and a very pretty sketch (fig. 72) gives a graphic idea of the general direction of Foucault currents.

This chapter is a well written concise statement of armature design.

Armature mechanical actions and reactions are next discussed, and the strain on the conductor is shown and measured in numerical examples. The equations for torque are given in various units, and curves connecting current and torque, and speed and torque are given. Stray power losses next follow for consideration, and their efficiency is defined in its various senses. The chapter winds up with the relation of size to capacity and efficiency. This much vexed question has been now solved, to all practical purposes, by actual trial, and it is certain that the design largely affects the slope of the curve connecting weight with output; but generally the output will increase as the cube of the linear dimensions, following a straight line law with considerable accuracy up to, say, 150 to 200 H.P. But it is undoubtedly necessary to change the shape and arrangement of the field magnets and the number of poles as the machines increase in size—for the design which would give good results at 50 H.P. would not necessarily do so at 200 H.P. We published a few weeks ago an article on the subject by Mr. Albion T. Snell, in which he shows that between certain limits the output varies sensibly as the cube of the linear dimensions.

Chapter VI. is on magnetic principles, and the magnetic properties of iron, and the next chapter is on the magnetic circuit. These are "up to date," and form probably the best treatise on the subject. Starting with the conception of lines of force, the professor gives a thorough definition and description of the electro-magnetic rules, and out of deference to the workshop gives all the important equations in inch-minute units, as well as in C.G.S. This makes the book doubly valuable, and gives it a far wider field of usefulness, for let the theorist say what he may, in practice the foot rule will still be used—we think more readily in minutes than in seconds, and the gramme is simply "impossible." We pointed this out in our review of the third edition, and

are glad to find the concession. The relation between magnetic induction, B, magnetising force, H, and permeability, u, is graphically traced, and the conflicting definitions of these much-abused symbols reduced to their *lowest terms*. On page 132 are Ewing's curves connecting B and H for wrought iron and steel, and on pages 140 and 141 Hopkinson's determination for wrought and cast-iron, all readings being in C.G.S. units. In fig. 94 similar curves are given with the inch as the unit, the symbols, $B_{||}$ and $H_{||}$, being chosen to denote the workshop unit. Figs. 95 and 96 show the relation of permeability to B and H, and in pages 146 and 147 are four tables and curves in various units, further elucidating these important relationships. The limits of B and u are next considered, and Ewing's figures for Swedish iron forms a finish to this complete collection of data.

Then follows a section on the air-gap, by no means the least instructive in the book. The effects of joints, stress, vibration, heat, and residual magnetism, are discussed in a useful manner, and finally the subject of hysteresis fills up the rest of the chapter. Viscous hysteresis is shown to be a true though slight magnetic lag; but we miss some of the more recent determinations of the proportionate losses due to *residual magnetism* and that due to *viscous hysteresis*.

The article on formulæ for the Law of the Electro-magnet is much curtailed with advantage.

The magnetic circuit, in Chapter VII., forms a suitable sequel to the preceding matter, and the application to practice of the principles enunciated is made clear. Stray field and leakage co-efficients are taken from the determination of Esson and others. We note the word *permeance* used for the magnetic conductance or $\frac{\text{area}}{\text{length}}$. The pre-determination of permeance and leakage co-efficient does not commend itself to us as a very practicable operation.

The chapter on field magnets contains the latest shapes and some good hints with reference to the use of double magnetic circuits with heavily loaded armatures.

We next come to the elementary theory of the dynamo. The arrangement of the matter is, on the whole, much as in the third edition, but parts of the chapters on shunt and series dynamos and economic co-efficients are combined under this head. Characteristic curves are treated in Chapter X., and the compound dynamo in Chapter XI.; but as is to be expected, the matter is much the same as before, only re-arranged. Chapter XII. is a very valuable addition, and gives a theoretical and practical treatise on armature winding and connecting up. The diagrams are many of them new, and nearly all are fresh to this work. This chapter and the one following on Practical Construction of Armatures form a very *vade mecum* for the practical man, and should help him over many constructional difficulties. The details of commutators, brushes, and brush holders follow in rapid succession, and then, to complete the working details, is a short chapter on mechanical points in design. There should be a very great improvement in dynamo and motor design, if these splendid additions are properly appreciated.

Chapter XVI. is entitled Elements of Dynamo Design, and gives a very practical view of the way in which the winding calculations are actually made in the drawing office. Of course, every designer will have his own method of "tackling a job;" but the principle underlying the attack are the same in all cases, and Prof. Silvanus Thompson has clearly put himself in touch with practice. But the equations given on pages 410 to 412 involve the permeability—when really there is no need to consider it, since we have the curve connecting B with H. If the co-ordinates be measured in suitable units, the ampère turns per centimetre, or per inch, for the desired value of B, are read direct, and no calculation involving the permeability is required. This avoids the quantity $\frac{4\pi}{10}$, which connects the absolute with the ampère turn units. We are glad to note also that equations are given for determining the excitation in inch units. The analyses of an Edison-Hopkinson and a Phœnix dynamo show the system somewhat more elaborated than that usually occurs in every day work; but, as numerical examples, they are excellent. The useful contributions of Esson and Swinburne to this branch of engineering are made very apparent, and their deductions on air gap, demagnetising turns, armature reactions, and load limits form some of the most valuable additions to the fourth edition. The importance of the multipolar design for large diameter slow speed dynamos is also recognised, both from continental and home practice. The section concludes with a mathematical note by Profs. Ayrton and Perry on the best depth of air gap. The highest permissible continuous output for a given machine is found to obtain when the magnetic reluctance of the space occupied by the winding on the armature is equal to the reluctance for the rest of the magnetic circuit. This is no doubt true, mathematically, but the condition is not an easy one to get in practice, where fixed sizes of iron and limiting values of speed are given. The student should note this, or he will attempt impossibilities.

The chapter on arc lighting dynamos does not contain much that is new, but then no radical improvements have been introduced in open coil armatures since the Thomson-Houston machine, and the Gramme type does not seem to have made much headway for high tension work. Amongst the examples of *modern* dynamos we notice many old friends —the Gramme A pattern and the Edison Z type, and we also miss several important machines, but this is inevitable in so comprehensive a work.

The continuous current electric motor receives the attention it deserves, and Chapters XX. and XXI. treat of it in theory and practice. We notice, however, nothing especially new, for nearly all the improvements in the transmission of power have been in the direction of multiphase alternate currents. Amongst the examples of modern motors we find the "Agir" of *Industries* fame. Has anyone ever seen one of these at work?

Alternate current machinery holds a much more important position than when the third edition was written, and hence we note with pleasure that about 150 pages of Prof. Thompson's book are devoted to its consideration. Chapter XXII. is largely a reprint of the principles of alternate currents as expounded in the previous edition, but the matter is amplified, and modern researches by Fleming and others are incorporated. Chapter XXIII. contains a fairly complete description of those alternators most in use, the whole being well classified. The effect of altering the ratio of width of pole face to breadth of armature coil is shown, and Kapp's calculation for the virtual E.M.F. is given. The controversial point of "iron" or "air" cores is mentioned, but no decided opinion is passed; this is probably a matter for time to settle. The effects of self-induction and capacity are not very fully treated, but the use of condensers is mentioned. Then follows an interesting section on inductor alternators. Multiphase currents of course claim a special section, and the subject is referred to in this chapter, and treated more fully in the following one, which deals with alternate current motors.

We look in vain for a promise of the single phase self-starting non synchronous motor, and find it still in the future. Laminated fields are discussed; but there does not seem to be much hope except from the Drehstrom.

The section on transformers is enlarged since the third edition, and contains some of the researches of Fleming, Ryan, and others. The diagrams on pages 731 and 732 are new to this work. The mathematical treatment is the same as before, with the exception of Prof. Perry's addition to the subject. This latter is a most important contribution.

Motor generators are considered under the head of transformers, and the part is enlarged. Modern types of these machines are referred to, and their utility for regulating, &c., is also touched upon.

The electric transmission of power has now a short chapter to itself. But the exposition is disappointing, and not worthy of such an important branch of modern engineering. The subject is commenced and finished in some ten pages. A slight introduction, a few geometrical diagrams, an algebraical proof or two, a reference to economy of transmission, Kapp's Cantor calculations, Forbes's tables, the mention of a few examples of plants, and the matter is dismissed. Like Oliver Twist, we ask for more!

Chapters XXVIII. and XXIX. are on the testing and management of dynamos and motors. They contain much practical information, and comprise valuable additions to the book. The index is very complete, and there is little difficulty in finding the whole of the references to any particular subjects.

At the end of the book are the 29 plates previously referred

to by us. These are a valuable collection of scale drawings, illustrative of modern heavy electrical engineering. The progress made since 1888 is to a large extent written on them, and the whole forms a very fitting finale to such a work.

In concluding our review, we take this opportunity of congratulating Prof. Silvanus Thompson on the fourth edition of "Dynamo-Electric Machinery." It is probably the most complete text-book on the subject. Our criticisms are offered, as before, in no captious spirit, and we believe that if they be duly considered, the fifth edition will be still more complete, and have even a wider field of usefulness than that we expect for the present one.

First Principles of Mechanical Engineering. By JOHN IMRAY and C. H. W. BIGGS. Illustrated. London: Biggs & Co.

According to a statement on the title-page, this is "An attempt to provide an Elementary Book, and to treat the subject without any but simple Mathematics." In this design, the authors have succeeded, and have given us a book which, as far as the matter treated of is concerned, is well written, simple, and lucid in its expression.

In the opening chapter (after some preliminary observations by way of clearing the ground) we have plain and correct definitions of the various terms employed in dynamics, and yet a few pages further on we have a two-page dissertation on horse-power, under the heading "Unit of *Work!*" Throughout the book too, in many instances, we note that the terms, *work*, *power*, and *energy* are misused very recklessly, and in a manner calculated to confuse rather than inform the young student. This arises, we believe from mere carelessness, for there are not wanting evidences that the authors are quite well aware of the difference between, and the correct meaning of these terms. In this chapter we have also a concise account of the nature of machines, and of different kinds of machines used for different purposes. Chapter II. deals with Mechanical Drawing and Drawing Instruments, in a comprehensive manner, and ought to prove useful to beginners. A number of the most important points in engineering drawing are treated of briefly and, to those who know a little of the subject, clearly enough, especially noticeable being the section devoted to shading. A novel point in this chapter is the application of geometrical methods to the shading of drawings, but we question if many draughtsmen will avail themselves of it. The Strength of Materials is next taken up and is treated in a very complete fashion for such a work. The stresses to which materials are subjected in machine and building construction, as well as the strains produced are very fully gone into, and a number of useful and easily understood tables are given. Most of the ordinary cases of compressive, tensive, and torsional stress are studied in detail, with reference to the behaviour of particular materials, and quite a number of arithmetical examples of a simple kind are fully worked out. The question of beams and girders is also gone into, and the best form, proportions, and disposition of materials is clearly expounded. A number of the usual simple formulæ are also given. The fourth chapter is devoted to the subject "Sources of Energy." The principles of the action of wind and water pressure are well set forth and considered. The latter especially is very ably treated, particularly with regard to undershot, overshot, and breast water wheels. Turbines, however, are dismissed with only a few paragraphs, though, in the light of modern practice, they are unquestionably of much more importance than the other forms of water motors. At page 199 a formula is investigated, which shows that, with undershot wheels, the maximum effect is obtained when the velocity of the float (v) is one-third of the velocity of the stream (V); or when $v = \frac{V}{3}$. It would, we think, have been much more useful to have given the velocity of the float (for maximum effect) *when working* in terms of its velocity *when running free*. The following chapter deals in an elementary manner with the nature and peculiarities of Heat Energy. Boyle's Law is simply explained, and the relation that exists between the temperature, pressure, and density of gases is distinctly shown. The rest of this chapter is devoted to a consideration of steam boilers and the various parts of steam engines. A number of useful illustrations and diagrams are also given. We are pleased to note that in one or two cases in this section the authors have adopted the common sense method, so strenuously advocated by Prof. Jamieson, of indicating the various parts by their initial letters, and we consider that it would have been advantageous to have adopted this plan throughout, in a book written specially for junior students. The sixth chapter takes up the subject of the Transmission of Energy by means of shafts, belts, toothed gearing, &c. We see with pleasure that that most important subject, the forms of the teeth, is explained and fully illustrated upon sound and approved methods. According to the heading, there ought to be treated also in this chapter, the friction brakes, dynamometer, resistance due to friction, friction straps, and frictional devices for engaging stationary with moving machinery. The last chapter, which is a short one, gives an account of the chemistry of combustion, together with the chief causes of the inefficiency of our present form of heat engines.

On the whole, the volume is a satisfactory one, and is well calculated to be of use to young students whose knowledge of mathematics is merely elementary. The main principles of the subject are clearly laid down and explained in simple language. The arrangement of the matter is good, and a just balance is observed between the various parts of the subject. We quite agree with the opening sentence of the preface, "The sins of an author or an editor of a technical book are usually those of omission rather than those of commission;" and while there are many points omitted which we should have liked to see touched upon, we fully appreciate the honesty of purpose with which the authors have confined their attention to what are unquestionably the principles of the subject, and the ability with which they have expounded these principles.

In the matter of attention to details and careful revision of proofs, however, there is room for much improvement. If we remember rightly, we had the same fault to find with the last volume of the series which was reviewed in these columns, and, although the present one shows that much more editorial care has been exercised, much yet remains to be done to secure absolute correctness and freedom from blemishes. There are numerous mistakes in spelling, grammar, and use of terms; in many cases the English employed is very slipshod and faulty; in a few instances reference is made in the text to letters which do not appear in the illustrations, and sometimes the drawings themselves are at fault. We may give a few samples by way of justifying these remarks. On page 51 "*two*" is spelt "*to*;" on pages 59 and 60 "*frustum*" is spelt "*frustrum*;" on page 75 "*dimensions*" appears as "*dimentions*," and we have the expression "any *mathematical accurate* mode;" on page 101, "to *render* it asunder." The three figures on pages 310, 311, and 313, all show left-handed screws instead of right-handed ones, while the formula on p. 87, $P = \frac{W \times A F}{A B}$ ought to be, $P = \frac{W \times A C}{A B}$, as there is no F on the diagram at all, while the longer arm of the lever is marked, A, C. An expression like this on page 177 is very inelegant—"the keys should be made *narrow and broad* (!) measuring the *breadth in the direction of the rods lengthways*;" while the following sentence from page 116 is quite incomprehensible—"The theoretical investigation of transverse stress is by no means a difficult one; but *the application of data in computation involves some very complicated questions, which the practical mechanic too often jumps at conclusions, as he sees proportions in his drawing or model, than by any very accurate calculation.*" All these are blunders which a little more care in revision would entirely have prevented.

The book is very clearly printed on good paper, and is substantially bound, and altogether is a credit to the publishers.

Journal of the Institution of Electrical Engineers. No. 98. London: E. & F. N. SPON.

The principal contents of this number are:—Paper and discussion on "Oil as an Insulator," by Prof. D. E. Hughes; discussion on A. Siemens' paper on "Some Experimental Investigations of Alternate Currents"; paper and discussion on "Load Diagrams of Electric Tramways, and the Cost of Electric Traction," by A. Reckenzaun.

Electrical Instrument Making for Amateurs. By S. R. BOTTONE. Fifth edition, revised and enlarged. London: Whittaker & Co., Paternoster Square.

We are not at all surprised at the success which this small book is attaining; thoroughly practical in all its bearings it is just such a work as amateurs would delight in. In the present edition a few simple instructions for making a small arc lamp, an incandescence lamp, a current reverser, &c., have been added.

SOME POINTS CONNECTED WITH THE ELECTROMOTIVE FORCE OF SECONDARY BATTERIES.*

BY DR. J. H. GLADSTONE AND MR. W. HIBBERT.

LAST month we communicated a paper to the Institute of Electrical Engineers "On the cause of the changes of Electromotive force in Secondary Batteries," which gave rise to a certain amount of discussion. Since then we have received a paper by M. Darrieus, entitled, "Essai de théorie chimique sur les accumulateurs Electriques au plomb;"† which was read before the Société Internationale des Electriciens on May 4th. In it he agrees with Prof. Armstrong and Mr. Robertson in attributing the large initial E.M.F. to persulphuric acid, and he opposes what he terms the most generally admitted theory of the production of sulphate during discharge, so far as the positive plate is concerned.

In our recent paper we had assumed the truth of the view put forth by Messrs. Gladstone and Tribe in 1882, that in discharge "Sulphate of lead is the ultimate product on both plates," and on discharging again "this lead sulphate is oxidated on the one plate, and reduced on the other." This conclusion was not received at first without powerful opposition, but it has won its way to general acceptance among workers on the subject. Among these may be specially mentioned Prof. Frankland, Mr. Swinburne, M. Reynier, Messrs. Kolrausch and Heine, Prof. Ayrton and his colleagues, and Mr. G. H. Robertson.

We can only attribute the finding by M. Darrieus of a large amount of oxide of lead mixed with sulphate on the positive plate to the fact of the difficulties of analysis, as it is hard to imagine that oxide of lead could remain as such when surrounded by sulphuric acid.

The reaction which takes place in discharging was expressed in our recent paper by the general equation.

$$Pb\,O_2 + H_2\,S\,O_4 \ldots H_2\,S\,O_4 + Pb = Pb\,S\,O_4 + H_2\,O \ldots H_2\,O + Pb\,S\,O_4$$

and the reaction that takes place on charging was expressed by the same equation reversed. It is to be understood that these equations represent the initial and the ultimate products, and take no note of any intermediate reaction. There have been numerous theories in regard to such intermediate changes, but on these we must be held at present to express no opinion.

It is evident that if the reaction consists in the alternate formation and reduction of $Pb\,S\,O_4$ there must be great changes in the strength of the sulphuric acid within the pores of each plate. How these changes must be affected not only by the electrolytic reaction, but by the influence of gravitation and of diffusion, by electrical transference, by local action, &c., is traced out in our paper. At the same time, continuing the experiments which were communicated to this society in 1890, we have not merely satisfied ourselves more fully that a change of strength of acid against the working surfaces of the plates results in a change of E.M.F. but we have determined the amount quantitatively for all strengths of acid from a mere trace to 99 per cent.

We show that the changes of E.M.F. in charge and discharge coincide fairly well with the changes of strength of acid deduced *a priori*. For this purpose we employed the determinations lately published by Prof. Ayrton and his colleagues, believing them to be the best. Our conclusion is, "that the changes of E.M.F. in a secondary battery depend on the strength of the acid that is against the working surfaces of the plates."

The only serious opponents of our views, so far as we know, are Messrs. Armstrong and Robertson. They have attributed the changes of E.M.F. to the persulphuric acid and hydrogen dioxide which are produced during the change. The experimental grounds of this conclusion are not yet fully published, but we are able to refer to their remarks in the discussion of our paper, as printed in the *Electrician* of last week. They commence by substituting for our general equation a complicated and unsymmetrical one, which at best can only be one form of it, and cannot represent those of our experiments that were made with the strongest sulphuric acid. Their subsequent remarks are addressed mainly to the supposed contamination of our sulphuric acid with the soluble peroxides, and to the probability of $H_2\,SO_4$ itself taking part in the reaction. Now, as to the first objection:—

Supposing that our plates in the first instance were not washed perfectly clean, there can be no reason why the trace of peroxide should always vary in amount with the strength of the fresh sulphuric acid in which the plates are dipped. As to the second objection: We have not speculated on hydrates of sulphuric acid in solutions, and have expressly stated that we "content ourselves at present with pointing out that the liquid in the secondary cell is a mixture or a chemical compound, of two different liquids—sulphuric acid ($H_2\,SO_4$) and water, in varying proportions."

The most tangible criticism is directed, not against our main experiments and argument, which are untouched, but against one of our confirmatory experiments. Messrs. Armstrong and Robertson say—"Two series of experiments were described by the authors, in which the E.M.F. developed on the one hand between two lead plates, and on the other between two peroxide plates in acids of different strengths was measured. They appeared to regard these results as very important, as they went so far as to draw conclusions from a curve obtained by integrating the two sets of observations." They might have added that this curve coincides, both in shape and magnitude, with that previously determined, when a Pb and Pb O_2 plate were placed together in different strengths of acid. They attribute the results obtained with the two peroxide plates to the lead supports, because "local action would set in and be at a maximum in the stronger acid, and therefore the lead plate of this couple would be more protected, and the support opposite would be more active against the peroxide of this plate." The explanation is ingenious, and we might welcome it, since it presupposes the truth of our own conclusion, that with a stronger sulphuric acid there is greater electrolytic action. It is indeed not impossible that the lead support may, in some cases, have a small influence on the result; but it is inconceivable that such large and uniform differences, and such close coincidences as those shown in our paper, could be due to the accidental operations of local action.

In this connection they claim support from an experiment of ours with a plate dried at 100 per cent., but a reference to table 5 will show that in that experiment we obtained, not the highest, but really the lowest readings.

In order to show that the increase of E.M.F. does not depend upon the presence or absence of persulphuric acid, we have, within the last few days, instituted the following two additional experiments:—

1st. A Pb plate and a Pb O_2 plate, perfectly free from dissolved oxides, were placed in pure sulphuric acid of 12 per cent. strength, a porous diaphragm being between the two. The E.M.F. was 1·945. Into this acid surrounding the Pb O_2 plate was placed one per cent. of persulphate of potassium; the E.M.F. remained at 1·945. The lead plate was then brought into the same compartment, so that both were exposed to the influence of persulphuric acid. The E.M.F. was scarcely changed, viz., 1·934.

2nd. A secondary battery was made with phosphoric acid instead of sulphuric acid. Observations were made with different strengths of this phosphoric acid, varying in specific gravity from 1·05 to 1·5. The E.M.F. increased with the strength of the acid, and in the full range there was a difference of 0·176 volt. The theoretical variation calculated by Lord Kelvin's thermo-chemical law from the known heat of dilution would be about 0·170 volt. Of course there was no persulphuric acid, and we cannot assume the presence of

* Read before the Physical Society, Friday, June 10th, 1892.

† This important paper is being reproduced in the ELECTRICAL REVIEW, the first portion appearing last week.—EDS. ELEC. REV.

any higher acid oxide of phosphorus corresponding to it, as such a compound is not known.

We have investigated the effect of charging and repose on the E.M.F. of a small accumulator with phosphoric acid as the electrolyte, and found the results quite analogous to those obtained with sulphuric acid as described in our paper read at this Society in 1890, when we first announced our view that "the abnormal amount of E.M.F. is due to the inequality of acid strength, and its gradual disappearance to equalisation of strength produced by diffusion."

NOTES.

An Electrical Exhibition at Milan.—It is proposed to hold an International Electrical Exhibition at Milan, Italy, in 1894.

The Electric Light in Paris Theatres.—The Theâtre des Nouveautes, at Paris, has recently been lighted throughout with the electric light by the Compagnie Continentale Edison. The installation comprises 564 incandescent and 2 arc lamps.

Electric Railroad Accidents in the United States.—According to the *Financial Times*, a cable from New York states:—"A serious accident has occurred on the Atlantic and Chattahoochie River Electric Railroad. Owing to the electric dynamos for supplying motive power having been disabled, dummy engines were employed in their place, and as a train drawn by one of these dummies was rounding a curve, it ran off the rails and fell down an embankment. Three persons were killed and twelve injured. Another electric railroad accident is reported from Wheeling, Western Virginia. Between that city and Bellaire an electric car ran into a crowded passenger train proceeding to Benwood. The electric car was completely demolished, and three of the occupants were killed."

River Pic-nics.—Of the many ways of traversing the historic waterway of the Thames none surely can be more delightful than the electric launch. To glide easily at a good speed over the river without steam or manual labour must be an almost perfect state to lazy lovers of water scenery. Electric launches will this summer figure prominently before the eyes of the public and in a way they have never done before. The Westminster Yachting Association have chartered the *Omicron* from Messrs. Immisch for the purpose of making daily river trips from Kingston-on-Thames to Chertsey and back, and to make things pleasant, luncheon will be provided on the way. On Saturday the first trip was made with a party of pressmen on board. The affair was a distinct success, and if the enjoyment of those who were on the boat may be taken as a forecast of the popularity of the trips with the public the Association need never look behind. A most moderate sum is required to enable one to take part in this pleasant day's outing. Half-a-guinea will make the matter right with the owners, and if another is added the additional luxury of a coach ride may be enjoyed to Kingston and back. Mr. A. H. Tripp, late with Mr. Ronald Scott, is the electrician in charge of the boat. The *Omicron* is at present the longest electric boat on the Thames, being 69 feet from end to end. The cells, 108 in number, of E.P.S. type, are placed in the middle of the boat and joined up two in parallel. They are made of ebonite, and placed on glass insulators. An eight H.P. Immisch motor is connected to the propeller by a somewhat long shaft. At full speed the motor takes 80 ampères, the full capacity of the cells being 85 ampères for 18 hours. The boat weighs about 18 tons, and will carry 50 passengers.

The Royal Society.—The following papers were down for reading before this society yesterday afternoon:—"Electro-chemical effects on Magnetising Iron," Part IV., by T. Andrews, F.R.S. "On a Multiple Induction Coil Machine, and its Results," by Lord Armstrong, F.R.S. "Voltaic Cells with Fused Electrolytes," by J. Brown. "Magnetic Properties of Pure Iron," by F. Lydall and A. W. S. Pocklington. "On the Potential Difference required to produce a Spark between two Parallel Plates in Air at Different Pressures," by J. B. Peace.

A new Electrical Company at Paris.—The business of M. Edouard Clemançon, of Paris, manufacturer of electrical apparatus, has been formed into a limited company, to be known as La Compagnie Générale de Travaux d'Eclairage et de Force, with a capital of £68,000.

Journalists on the Thames.—On Saturday the reporters employed in the two Houses of Parliament held their annual dinner at the Sun Hotel, Kingston-on-Thames. An enjoyable feature of the day's outing was a pleasant trip down the Thames in the electric launch, the *Rawson*, which had been kindly placed at the disposal of the pressmen by Messrs. Woodhouse & Rawson United, Limited, of the Strand Electric Launch Works, Chiswick. Forty journalists took advantage of this little trip, and all were favourably impressed by the ease and steadiness with which the launch was propelled. During the run the *Rawson* was passed by a magnificently fitted electric launch called the *Glowworm*, the property of Mr. Pears, of soap fame, and which was built for that gentleman by Woodhouse & Rawson.

The Chicago Exhibition.—Mr. H. T. Wood, secretary of the Royal Commission, Society of Arts, has written the following letter to the *Times*: "My attention has been called to an advertisement by Messrs. Hall, Ramsdale & Co., offering employment at the Chicago Exhibition. I understand that the advertisers offer to put people in the way of finding employment on payment of a fee of 1s., stating that they have obtained special information from the 'London Management,' and that they are about to communicate with exhibiting firms. Will you allow me to say that I have no knowledge of these people, that they have obtained no information from this office, unless it be that contained in a circular which would be given to any one asking for it, and that, as no list of exhibitors has been issued as yet, no opportunity has been afforded enterprising agents of communicating with them?"

Tanning by Electricity.—The Grange Syndicate, Limited, which was incorporated for the purpose of experimenting and developing a patent process for tanning leather by electricity, is being wound up, operations having been suspended for want of funds, and the total deficiency amounts to £2,129. The failure is attributed chiefly to the inability of Mr. Groth, the patentee, to dispose of his foreign patents. So far as the experiments of tanning by electricity has proceeded, it is claimed that it has been a success, and that leather submitted to the process has turned out in a condition which, under better financial support would have proved remunerative.

Chatham and District Electric Lighting.—In spite of the many difficulties which have been encountered, the directors of the Chatham &c., Electric Lighting Company are confident that before long the light will be installed in many more places of business and private residences throughout the district. The new works in Whittaker Street, Chatham, have just been opened, and are found to be eminently suited for the requirements of the company. The company will shortly commence to lay their mains underground, as according to the terms of their provisional order they are bound to carry out this work by the end of August.

Great Northern and City Railway.—Full details of the proposed Great Northern and City Railway have now been published by the promoters of the undertaking. The project differs, says the *City Press*, from the other five short lines projected in London, in the fact that the line is intended to receive and carry ordinary railway stock. It will be between 3 and 4 miles in length from the junction with the Great Northern system at Drayton Park to Moorgate Street, through a 16-foot tunnel, with intermediate stations at Essex Road and Old Street. The estimated cost of construction is £1,200,000, and £250,000 for electric installation plant and lifts; but power is taken to raise £2,000,000 of capital.

The Azores Cable.—A Reuter's telegram from Lisbon, on 11th inst., states that "The contract concluded between the Portuguese Government and a French company for laying a cable to the Azores was signed to-day.

Gas and Electric Light.—It is frequently urged, says *Industries*, that the high price of coal in any locality militates against the introduction of the electric light. As a matter of fact, it is the other way. Where coals are dear electric light cannot be cheap, but gas must be dear. The cost of the coal is only a small item in a central station, but it is a much more serious matter in a gas works. The dearer coal is, therefore, the more chance the electric light has of competing with gas. We are competing with gas, but so far electric light is, of course, much dearer than gas. The real competitor of gas is not electricity, but petroleum.

Fatal Accident on the City and South London Railway.—Mr. Alfred Edward Stewart, a gentleman living at Battersea Rise, met with a fatal accident on the electric railway last Friday afternoon. The unfortunate man was a passenger by a train leaving the Elephant and Castle Station for Stockwall at about ten minutes to four o'clock, and was run over by the train within 200 yards of the Elephant and Castle Station. When the train was brought to a standstill, it was found that the unfortunate man was beneath one of the carriages, and it was necessary to disconnect and lift it before he could be extricated. This work was promptly proceeded with, but Mr. Stewart, although he breathed for twenty minutes after the accident, was quite dead when taken out. It was then ascertained that his ribs were badly broken, and that some of the wheels had passed over his groin. Mr. T. Jenkins, the general manager of the company, and Mr. Basil Mott, the engineer, were quickly in attendance, but the traffic could not be resumed until half-past seven o'clock. At the inquest held on Monday last, John Gardener, a guard in the employ of the City and South London Electric Railway Company, said that three gentlemen got into his train at King William Street, and took their seats in the smoking car nearest the engine. Near the Borough Road station witness entered the compartment, and was asked by one of them if they were passing under the Thames. Witness explained to them where they were, and left. After they passed the Borough Road station witness was asked if the motive power was under the seats. Witness told them no, and asked them if they would like to see the engine at work, to which they replied "Yes." After leaving the Elephant and Castle station, he motioned to the gentlemen to follow him. He opened the front door, and one of the gentlemen walked out and placed one foot on the buffer plate of the engine while the other rested on the platform of the carriage. The deceased then followed, and in attempting to pass his friend slipped between the engine and the platform of the carriage. Further examined, he said that he knew he had infringed the rules of the company, and after the accident he ran away. Although it was stated by a witness that the face of the deceased man was charred, medical evidence showed that this was not the case. Mr. Basil Mott, engineer to the company, said that, providing the deceased stepped down between the platforms, his legs would be caught by the sleepers and his body drawn under the train. A passenger had no right on the platform at all, as it was most dangerous. Mr. T. C. Jenkins, the general manager of the company, said that the door at the end of the train was specially locked, and the guard had no right to open it except in a case of emergency; he had been suspended from duty, and his case would be brought before the board in due course. The jury returned a verdict of "Death from misadventure," and added that there was great negligence on the part of the company's servant.

Electric Locomotives.—Prof. Silvanus P. Thompson writes to us again:—"In your issue of June 3rd you were good enough to publish a correction in the new edition of my 'Dynamo-Electric Machinery.' I desire to supplement this by saying that the statement that the electric locomotives supplied by Messrs. Mather and Platt, Limited, for working the City and South London Railway 'are now being replaced' by others, is not only technically inaccurate, but altogether incorrect, and to express my regret that inconvenience and annoyance should have been caused to Messrs. Mather and Platt by such a statement. I now learn from Messrs. Mather and Platt that the rolling stock of the electric railway is about to be increased by the addition of another locomotive which is being constructed by them."

Bradford Central Station.—Mr. Baynes informs us that the insulation resistance should read "5,000 ohms" instead of 500 as stated by us last week, but the figure given was taken from the *Society of Arts Journal*, which contained Mr. Shoolbred's paper and the discussion.

The Government and the Telephones.—A committee of the House of Commons yesterday passed the Bill enabling the Treasury to raise a million of money for the purchase of the trunk lines of the various telephone companies. No final arrangements have yet been arrived at between the Post Office and the companies, and the committee intimated that it was their opinion that details of the proposal should be prepared and submitted to Parliament. They, however, allowed the bill to pass substantially in the form in which it was brought before them.

Conversazione of the Royal Society.—At the conversazione of the Royal Society, on Wednesday evening, Prof. Crookes again showed his interesting experiments with electric currents of high potential and a frequency as high as 1,000,000 a second. He also stated the grounds on which he has arrived at the conclusion that the flame produced by exciting an induction coil by means of an alternating current in the way that has lately been exhibited at the Crystal Palace, by Messrs. Siemens Bros. and by Messrs. Swinburne & Co., is really due to the combustion of nitrogen. Mr. Wimshurst showed some exceedingly brilliant effects arising from the passage of electrical discharges over imperfectly conducting surfaces of considerable area, the colours varying according to the nature of the conducting medium. Mr. A. A. A. C. Swinton exhibited some photographs of these discharges, which he obtains without the employment of any lens, by merely causing the discharges to take place across the sensitive surface of gelatino-bromide dry plates.

The Telephone in Russia.—The Moscow correspondent of the *Daily News* telegraphs that St. Petersburg and Moscow are to be connected by telephone this summer. The distance is 409 miles.

NEW COMPANY REGISTERED.

Electric Clock Company, Limited.—Capital £1,200 in £1 shares (of which 30 are founder's). Objects:—To carry on any business which may be considered advisable by the company; and in particular to carry into effect an agreement between Leon Pope, of 98, Richmond Road, Barnsbury, electrician, of the one part, and the company of the other part. Signatories (with one share each): S. St. J. Steadman, F. Orme, A. Sims, and G. Stephenson, all of 23, Old Broad Street, E.C.; R. L. Adams, Standon, near Ware; R. H. Rabson, 12, Percy Road, Finchley; Leon Pope, 98, Richmond Road, Barnsbury, N. The number of directors is not to be less than two nor more than seven, and until directors are appointed, the above signatories shall be deemed to be directors. Qualification, £50; remuneration as the company by ordinary resolution determine. Registered on the 9th inst. by Steadman, Van Praagh, and Sims, 23, Old Broad Street, E.C.

BUSINESS NOTICES, &c.

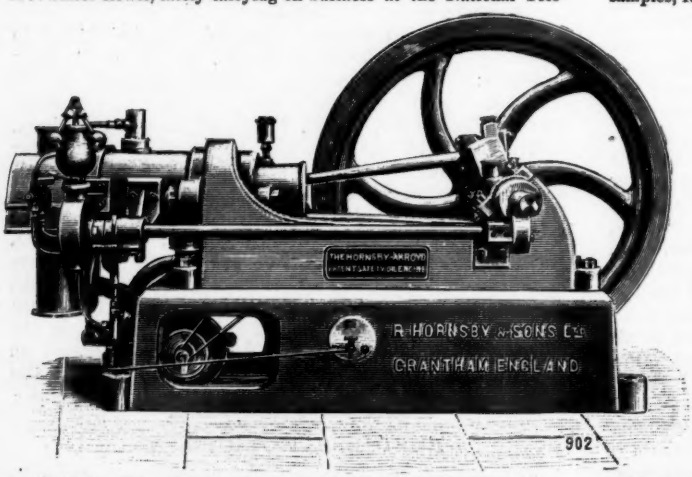
Electric Lighting in Dundee.—The Contracts.—At a meeting of the Dundee Gas Commissioners on June 3rd, a report, of which the following is an abstract, was submitted:—"Of the 42 firms who have tendered for the execution of the work in connection with the electric lighting station, four, namely, Messrs. Crompton and Co., Limited, Messrs. Sharp & Kent, the Brush Electrical Engineering Co., Limited, and the Electric Construction Corporation, Limited, have tendered for the whole six contracts; Messrs. Latimer Clark, Muirhead & Co., Limited, and Messrs. Anderson and Munro for four of the contracts. Of the four firms tendering for the whole works the Electric Construction Corporation, Limited, are the lowest, and the amount for which they undertake to complete the work is £18,213 10s., or £17,433 10s., according to the kind of mains adopted. By taking from each list the lowest tender which we could recommend, we find that it would be possible to get the work done for £17,016, as compared with the offer of £18,213 by the Electric Construction Corporation, Limited, *i.e.*, a difference of £1,197. They recommend the acceptance of the tenders of the Electric Construction Corporation, Limited, subject to an alteration for the distribution mains, which would increase the cost by £250. Should you, however, consider that the advantages attaching to one contractor for the whole work would be too expensive, we should suggest that the fol-

lowing tenders be accepted:—1, Messrs. Whyte & Cooper, £1,735; 2, The Steel Pipe Company, Limited, £1,350; 3, Willans & Robinson, Limited. £3,500; 4, The Electric Construction Corporation, Limited, £2,762; 5, The Electrical Power Storage Company, Limited, £955 18s. 6d.; 6 (feeders), The Callender Bitumen, &c., Company, Limited, £2,505; (distribution) The India-Rubber, &c., Company, Limited, £4,445—total, £17,252 18s. 6d." After discussion, the meeting resolved as follows:—(*a*) To accept the tenders of Willans and Robinson, Limited; Electrical Power Storage Company, Limited; Callender Bitumen, Telegraph, and Waterproof Company, Limited; and the India-Rubber, Gutta-Percha, and Telegraph Company, Limited, as above specified—caution to be dispensed with in each case; (*b*) that the tender of Messrs. Siemens Brothers & Co., Limited, of £2,632, for contract No. IV., be accepted in place of that of the Electric Construction Corporation, Limited, caution being also dispensed with. The Clerk was instructed to accept in terms of the foregoing resolutions.

Lighting of the New Royal Pier, Southampton.—This pier, which was opened by H.R.H. the Duke of Connaught, K.G., on Thursday, June 2nd, 1892, is lighted throughout by the electric light, the current being supplied from the local supply Company's station. The installation is divided into three circuits, each controlled by separate switches on the switchboard. The switchboard is placed in the cloak room and contains besides the switches for the three circuits two ammeters and one voltmeter, and the usual fuse terminals for each circuit, &c. The cables are carried in cast-iron pipes securely fastened under the decking and provided with inspection boxes at every 20 feet apart, also service boxes at every lamp column. The lamp columns are provided with two arms, each carrying a clear glass globe containing three 50-C.P. lamps, 20 feet from the deck. The light on either arm can be switched off or on by means of switches placed in the base of the column. At each of the three landing stages is placed an ornamental arch 15 feet high with one 50 C.P. lamp suspended. In the open space near the band stand is fixed a lattice pole 45 feet high, carrying three 3,000-C.P. Crompton arc lamps, which light a space of 30,000 square feet so effectively that small print may be read easily. The band stand is lighted by eight pendants, each carrying lamps of 16 C.P. The lavatories, ticket offices, entrances, gangway, pontoon railway station, &c., are all well lighted and provided with suitable fittings, &c. The work has been carried out by the contractor, Mr. F. Shalders, Southampton, assisted by Mr. T. Davis, under the supervision of Mr. J. G. W. Aldridge, 9, Victoria Street, S.W., electrical engineer to the harbour board.

The Western and Brazilian Telegraph Company, Limited.—The Western and Brazilian Telegraph Company, Limited, have just received telegraphic advices of the successful laying of their duplicate cable between Rio Janeiro and the River Plate, thus completing the direct duplicated system of their telegraphs between this country, Brazil, Uruguay, and the Argentine Republic.

Re J. Slater Lewis.—A meeting of the creditors of J. Slater Lewis, lately carrying on business at the National Telegraph Works, Aston, Birmingham, was held last week. The statement of affairs showed the liabilities to be £1,613, and the assets *nil*. The bankrupt's insolvency was attributed to being unable to obtain sufficient capital to work the National Telegraph Works properly.



Mining and General Electric Lamp Company, Limited.—With reference to the paragraph which appeared in our issue of the 10th inst., saying that this company was in liquidation, we are requested to point out that the liquidation is only with a view to reconstruction, which is now in course of completion. Meantime the business is being continued.

Electric Lighting in Factories.—Messrs. Lowdon Brothers, electrical engineers, Tay Street, Dundee, have received a contract to fit up an electrical installation in Station Works, Forfar (Messrs. W. and J. Don & Co.). The contract will embrace between 300 and 400 lamps.

Electric Lighting of Chiswick.—Mr. Morgan Williams has been retained by the Chiswick Local Board to advise and report on the carrying out of the electric lighting order at present held by the Board.

Shop Window Electric Lighting.—A new form of lantern for the above purpose has just been put in the market by Messrs. Smeeton and Page, of 63, Queen Victoria Street, E.C. From the cuts it will be seen that it is somewhat similar in appearance to the ordinary gas lantern, and is composed of silvered corrugated glass, instead of silver-plated copper, which the ordinary run of lantern is made of. It is connected to the shop fascia by means of a detachable contact, as shown, and can be easily removed, when out of use, in the same manner as an ordinary gas lantern. When the lantern is removed, the front contacts fixed to the fascia may be short circuited,

without having any effect on the fuse, even if the controlling switch is on, as no current can pass until the lantern is in position, which also renders surface leakage impossible. Both the lantern and contact are very neat and effective, and are made in various sizes, and can be adapted to any window. They have been erected at the new premises of Messrs. Loewenstark and Sons, of 110 and 111, Strand, W.C., where they have proved a complete success. Many advantages are claimed for it, and the above firm will be pleased to submit samples, for approval, to the trade, or intending purchasers.

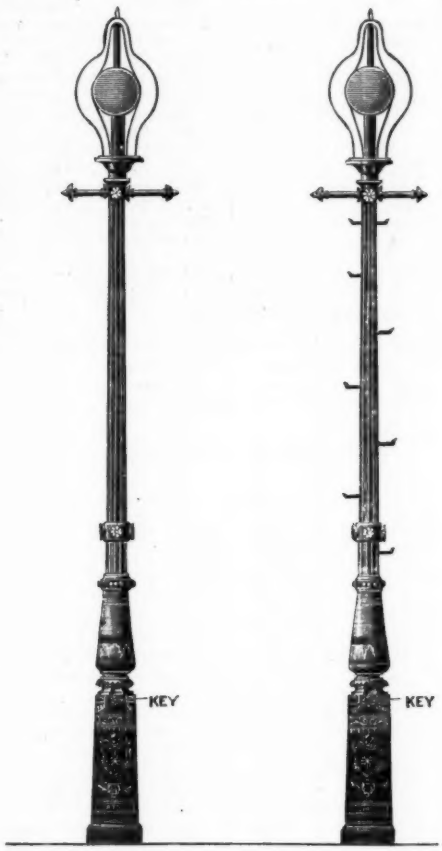
The "Hornsby-Akroyd" Patent Safety Oil Engine.—The engine, manufactured by Messrs. R. Hornsby and Sons, Limited, of Grantham, has now passed the experimental stage, and is placed upon the market as the simplest oil engine yet produced. Its chief claim to this title is, that beyond a few minutes' heating up with a lamp before running, no other lamp, electric spark, or other means is used to cause the explosions when the engine is running. Oil of a specific gravity of ·85 is used, with the result that the cost of running is reduced to one half-penny per indicated horse-power per hour. The engine is made in various sizes, and Messrs. Hornsby exhibit 4½, 8½, and 12 I.H.P. engines at the Royal Show at Warwick, all of which are driving dynamos for electric lighting.

New Branch.—Messrs. Woodhouse & Rawson United, Limited, inform us that they have recently opened a branch office, show-room, and stores, at 16, Fleet Street, Dublin, their former agencies at Belfast and Cork being given up, and the whole of their Irish business concentrated in Dublin under the management of Mr. Arthur H. M. Francis, to whom all communications should be addressed.

Electric Launches on the River.—We notice that several improvements have lately been made in some of the electric launches now running on the river. The *Myionn*, Captain Homfray's favourite boat has been fitted up with Epstein accumulators, and had a new "W. & R." motor placed in her. This enables her to run at a much higher speed than formerly. Indeed, with the exception of the *Metadel*, she is the fastest electric launch on the river. It is also found to be a great convenience to be able to charge the accumulators at the rate of 50 ampères, as this enables the cells to be fully charged in about three hours instead of six as formerly. A number of improvements have also been made in the *Pioneer*, including the fitting up of a new motor. The steering gear has been carried forward to enable a neat cabin to be put over her. She is now being used by the officers of the 3rd battalion Grenadier Guards at Windsor, and thanks to the simplicity of the new patent single lever switch, fitted in her by her makers, Messrs. Woodhouse & Rawson, they are able to dispense with all assistance in working her.

Telephone Amalgamation.—The business of the Universal Telephone Company has been taken over by the National Telephone Company, Limited.

Patent Electric Pillar Ladder.—We referred in these columns in a recent issue to Messrs. Smith & Son's Electric Pillar Ladder. We have now pleasure in illustrating and describing this. The object of the invention is to provide a safe and simple means of ascending high pillars, such as those used for electric lamps and wires, and to do away with the necessity of those requiring to ascend having to carry with them long ladders or movable pins. By a turn of key at base of pillar the rod or chain may be raised, thus causing the steps to shoot out, forming a safe and strong ladder, and by a reverse turn of key the rod or chain is lowered, thus withdrawing the steps inside the shaft; the outer end of steps taking their places as ornaments, or forming part of the plain shaft. The steps when shot out are perfectly rigid, and cannot, even by a failure of gearing, fall out or give way. The gearing causing the movement of rod or chain, is fixed in base clear of all electric switches, &c., and takes the



form of an eccentric wheel or cranked horizontal bar. All through, the workings are so simple as to reduce the possibilities of disarrangement to a minimum. Sufficient foot hold is given on the steps, and a raised check is formed on extreme end to prevent the foot slipping off. The gearing is also arranged that the steps can never get beyond the horizontal. The steps can be renewed or taken out, but only by those in charge, and all danger from mischievous or malicious persons is completely averted. For situations where there is no danger of the steps being tampered with, the inside gearing may be dispensed with, the man in charge taking them out as he ascends, and closing each one as he descends. The steps are so weighted that they will remain either in the closed or open position.

The Electric Light in the City.—The amount of work in private buildings at present being carried out in the City somewhat fell off a short time ago. However an improvement is now to be noted, quite a number of installations being in progress. Messrs. D. Hulett & Co., Limited, of High Holborn, W.C., have fitted up an installation at 40, King Street, Cheapside, and the Brush Electrical Engineering Company, of Lambeth, are fitting up an installation at 58, Lombard Street, E.C.—The premises of the Institute of Accountants, in Moorgate Street, are being installed by Messrs. Sharp and Kent, of Victoria Street, Westminster.—The Corporation Chambers, in Guildhall Yard, E.C., are being installed by Messrs. Joel & Co., Finsbury.—Messrs. Straker's premises in Gracechurch Street are being installed by Messrs. Rashleigh Phipps and Dawson, of Berners Street, W., while the newly-erected buildings in Golden Lane are being installed by Messrs. Edmundsons, Limited, of Westminster.

Electric Lighting of the Huddersfield Town Hall.—Messrs. Mather & Platt have obtained, through their London office, the contract for the lighting of the Huddersfield Town Hall, the work consisting of fitting up the building complete with 271 16-C.P. lamps, 16 32-C.P. lamps, 319 50-C.P. lamps, and 14 100-C.P. lamps. The current will be obtained from the central station, now in course of erection.

Country House Lighting in South Wales.—Messrs. J. B Saunders & Co., of Cardiff, have been instructed by Mr. J. H. Insole to instal a complete plant for the electric lighting of Ely Court, Llandaff. An electro-motor will also be fixed some distance from the engine house for pumping. The prime motor will be a gas engine. The same firm have also been entrusted with the contract for fitting up a complete installation at Velindra House, Llandaff, for Mr. P. A. V. Robinson. A 7-brake H.P. Priestman's oil engine will be used to drive a Phœnix dynamo, which will supply the current for the accumulators.

Bergtheil and Young.—Mr. Arthur Bergtheil and Mr. H. Wilson-Young have started as electrical engineers and contractors at 13, Walbrook, London. We understand that Mr. Bergtheil (late manager of the Wenham Company's electrical department) carried out, amongst other installations, Madame Patti's, at Cray-y-Nos, and Holland House, South Kensington, and also that he was the designer of the unique Windmill plant at Messrs. Carwardine's in City Road. Mr. Young was formerly with Messrs. Clarke, Chapman & Company, Gateshead-on-Tyne.

Ship Lighting.—Messrs. W. Simons & Co., of Renfrew, N.B., have recently launched a large steel twin-screw hopper dredger for the Russian Government. It will be lighted throughout by electricity.—A powerful dredger has recently been launched from the shipbuilding yards of Messrs. Dubigeon, at Nantes, France, for use in connection with the harbour works at Nantes. The vessel is being fitted with the electric light throughout.—The electric lighting of the training ship *Shaftesbury* is being carried out by Messrs. Paterson and Cooper.

Western Counties and South Wales Telephone Company.—This company has recently got up a new trunk line map, showing all its latest trunk line connections. At the foot of the map an interesting table is given, which, as usual, speaks well of the progress of the company's business since 1885. There is no doubt that an immense amount of telephonic communication is carried on in that part of the United Kingdom. The gross revenue for the year 1891 was £36,759, against £32,837 in the preceding year, and £26,803 in 1889, thus making an increase of over £10,000 in two years.

Tenders Wanted—Manchester.—The Gas Committee of the Corporation of Manchester are prepared to receive tenders for the electric wiring of the Town Hall. General conditions and specifications can be obtained on application (in writing only) to Mr. C. Nickson, superintendent of the Gas Department, Town Hall. A deposit of two guineas, which will be returned on receipt of a *bonâ fide* tender, must accompany each application for a tender form. The committee do not bind themselves to accept the lowest or any tender. Sealed tenders, addressed to the Chairman of the Gas Committee, and endorsed "Tender for Electric Wiring of Town Hall," must be delivered at the Gas Offices, Town Hall, not later than 10 o'clock a.m. on Tuesday, 5th July, 1892.

Tenders Wanted—Germany.—Das Material Bureau of the Königliche Eisenbahn Direction, at Hanover, are inviting tenders until the 30th inst., amongst others for 10,000 zinc elements, 7,000 copper elements, 78,800 kilog. of galvanised iron wire of varied diameter, and 4,000 metres of steel wire of 4 mm. diameter.

Tenders Wanted—Telegraph Stores.—The Highland Railway Company are inviting tenders for certain sundry stores to be supplied from July 31st, 1892, to June 30th, 1893, delivered free of all charges *via* Dunkeld, at the company's storehouses, Inverness.

McInnes and Company.—Messrs. McInnes & Co. have commenced business as manufacturing electricians and electric light engineers at Magenta Street, Woodgate, Leicester.

CITY NOTES.

Greenwood & Batley, Limited.—The fourth annual ordinary general meeting of the shareholders of Greenwood and Batley, Limited, was held at the company's office, 16, Great George Street, Westminster, S.W., last Friday, Mr. Arthur Greenwood, presiding. The Chairman, in moving the adoption of the report and accounts, said he regretted that this year the company had not done the favourable business which was at one time anticipated. The engineering business and the iron trade generally had been in a depressed condition. The directors might have declared a small dividend on the ordinary shares, but the board thought it prudent not to do so. He concluded by moving the adoption of the report and accounts, and the payment of a dividend of 7 per cent. on the preference shares.

Commercial Cable Company.—The Commercial Cable Company announce the payment on July 1st of a quarterly dividend at the rate of 7 per cent. per annum.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 10th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, amounted to £2,622.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, June 9th.	Closing Quotation, June 16th.	Business done during week ending June 16th, 1892. Highest.	Lowest.
250,000£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	101 —104	101 —104	...	...
1,300,980£	Anglo-American Telegraph, Limited	Stock	48 — 49	48 — 49	48	...
2,849,510£	Do. do. 6 p. c. Preferred	Stock	88 — 89	87½ — 88½	88¾	87¾
2,849,510£	Do. do. Deferred	Stock	10¾ — 11¼	10¾ — 11¼	11	10 9/16
130,000	Brazilian Submarine Telegraph, Limited	10	10¼ — 10⅝	10¼ — 10⅝	10⅝	10⅜
53,200£	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	105 —109	105 —109	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅞ — 3⅛	2⅞ — 3⅛	3 1/16	3
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2¼	2 — 2¼	2¼	...
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½ — 4½	3½ — 4½	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½ — 3½	2½ — 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	9⅝ — 10¼	9⅝ — 10¼	10⅛	...
$7,716,000	Commercial Cable, Capital Stock	$100	158 —163	155 —160xd	158½	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	⅛ — ⅜	⅛ — ⅜xd	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5¼ — 5⅝	5¼ — 5⅝	5 11/16	5¼
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	...	...
6,000	Do. do. 10 p. c. Preference	10	16½ — 17½	16½ — 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼ — 3⅜	3¼ — 3⅜	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11½ — 11⅝	11½ — 11⅝	11⅝	11⅝
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜ — 15	14⅜ — 15	14 15/16	14⅜
70,000	Do. 6 p. c. Preference	10	15¼ — 15⅝	15¼ — 15⅝	15⅝	15⅝
200,000£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000£	Do. 4 p. c. Mortgage Debenture Stock	Stock	108 —111	108 —111	109⅜	109½
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15¼	15 13/16	15
78,300£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	...	...
276,200£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	108 —111	108 —111	110	109
135,000£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	...	...
180,400£	Do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
201,600£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104	101 —104	104½	102½
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5½ — 6	5½ — 6	5⅞	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1½ — 1⅝	1½ — 1⅝	1⅝	1½
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2½ — 2⅝	2⅝ — 2⅝	2⅝	2 5/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅜ — 1⅝	1⅜ — 1⅝	1⅜	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10¼ — 10½	10¼ — 10½	10½	10¼
180,042	Do. do. 6 p. c. Preference	10	15½ — 15⅝	15½ — 15⅝	15⅝	15⅝
150,000	Great Northern Tel. Company of Copenhagen	10	18⅝ — 19¼	18⅝ — 19¼	19⅛	18⅝
220,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	106 —109	...	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7⅜ — 8¼	7⅜ — 8¼	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½ — 10½	9½ — 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	19½ — 20½	19½ — 20½	20½	20
200,000£	Do. do. 4½ p. c., Deb., 1896	100	104 —106	104 —106	104	...
17,000	Indo-European Telegraph, Limited	25	40 — 42	40 — 42	41½	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	3½ — 4½	3½ — 4½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 7/16 — 3 9/16	3 7/16 — 3 9/16	3½	3⅜
10,000	Do. do. fully paid	5	5 1/16 — 5 1/16	5 1/16 — 5 1/16	5⅛	4⅝
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	7¼ — 7⅜	7¼ — 7⅜	7⅜	7⅛
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜ — 4⅝	4⅜ — 5	4⅝	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	13¼ — 13¾	13¼ — 13¾	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12½ — 13	12½ — 13	...	...
420,000£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	108 —110	108 —110	109½	108⅞
250,000£	Do. (issued at 5 p.m., all paid)	...	104 —106	104 —106	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4 — 5	4 — 5	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16 — 5/16	3/16 — 5/16	...	...
9,000	Reuter's Limited	8	7 — 8	6½ — 7½xd	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8½ — 9	8½ — 9	...	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	7⅞ — 8¼	8	...
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3½ — 4	3½ — 4	3 9/16	3 7/16
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	44 — 46	...	...
150,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	1½ — 2½	1½ — 2½	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400£	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	100½	...
30,000	West Coast of America Telegraph, Limited	10	3½ — 4½	3½ — 4½	3 7/16	...
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	103 —107	104 —108	104½	...
67,007	Western and Brazilian Telegraph, Limited	15	9¼ — 9⅜xd	9¼ — 9⅜	9 9/16	9¼
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½xd	6 — 6½	6½	...
30,364	Do. do. do. 5 p. c. Deferred	7½	3½ — 3⅝xd	3 — 3½	3½	...
189,700£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	105 —108	105 —108	...	...
237,200£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	105 —108	105 —108	...	...
88,321	West India and Panama Telegraph, Limited	10	1¼ — 1½xd	1¼ — 1½	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9¾ — 10½xd	9¾ — 10½	9¾	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8 — 9 xd	8 — 9	...	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	102 —106	104 —108	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100£	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6½ — 7	6¼ — 6⅜	6⅝	6½

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid 7¼—7⅜.—Electric and General Investment, shares of £5 (£1 paid), 2—2¼.—Founders' shares, 150—200.—Elmore Foreign and Colonial Copper, Founders shares, 6¾—7¼.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2½—3½.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅜—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5⅜—6.—Liverpool Electric Supply Shares of £5 (fully paid), 5⅛—5⅜.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—⅜.—Metropolitan Electric Supply Company, Founders' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—½.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—½.—Do. Debentures, 103—½.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ¼—½.—£5 Preference (fully paid), 2½—3.—Ward's Electric Car (£10 paid), 1⅜—1⅝.

BANK RATE OF DISCOUNT.—2 per cent. (April 28th, 1892).

LEGAL.

The Electric Railway and Compensation.—On Monday Messrs. Saqui and Samuel, as holders of a portion of the premises, 45, King William Street, City, appealed to the Master of the Rolls and Lords Justices Bowen and Kay, from the discharge by Justices Day and Charles of an order *nisi* for a certiorari to bring up an inquisition on a compensation inquiry under the Lands Clauses Act.

It appeared from the statement of Mr. CRUMP, Q.C., for the appellants, that they held the ground floor and basement of the premises on a lease for 23 years, under a Mr. Wright, who was the original holder under Mrs. Lovering, the owner. Appellants gave him £250 for the lease, and had to fit up the shop as a fruiterers'. The company, in carrying out their works in 1888-9, so disturbed the ground by the erection of their tunnel and a neighbouring shaft, that it became necessary to underpin the wall between 45 and 46, and to make good certain cracks. The question of compensation—the cost estimated by surveyors at nearly £1,000—came before a jury sitting in the Secondaries Court in the City of London, who found for the defendant company, consequent very largely—as appellants' counsel now submitted—through their having been allowed to be improperly placed before them an award on a reference to Mr. (now Mr. Justice) Vaughan Williams of £1,700 to Mrs. Lovering, the owner of the superstructure. Not only, it was submitted, had this nothing to do with appellants, who would have to leave the premises in proper order at the close of their sub-lease, but it amounted to misdirection that it should have been allowed to come before them.

At the conclusion of some half-a-day's arguments, without calling on counsel for the company, the Court dismissed the appeal.

The MASTER OF THE ROLLS said that even if the admission of the award to the landlady and reversioner were wrong, there was, apart from it, sufficient evidence by expert witnesses called, to justify the jury in arriving at a decision which that Court saw no reasonable ground for disturbing.

The Lords Justices concurring in this view, the appeal was dismissed.

NEW PATENTS—1892.

9,719. "Improvements in electric lamp holders." O. T. COOPER. Dated May 23rd.

9,741. "Improved electric miner's lamp-lighter." F. J. MORGAN and W. R. JAMES. Dated May 23rd.

9,745. "Improvements in and appertaining to telephone transmitters or microphones." E. F. FURTADO. Dated May 23rd.

9,746. "Improvements for electro-telephonic receivers." E. F. FURTADO. Dated May 23rd.

9,747. "Improvements in electro-telephonic switching apparatus." E. F. FURTADO. Dated May 23rd.

9,748. "Improvements in or relating to armature and transformer cores and the like." W. L. SPENCE. Dated May 23rd.

9,758. "Improvements relating to the regulating of electric arc lamps." E. E. BEAUVALET and L. C. BEAUVALET. Dated May 23rd.

9,799. "Improvements in apparatus and means for the electrolysis of alkaline chlorides which may be in conjunction with earthy chlorides. D. G. FITZGERALD. Dated May 24th.

9,800. "Improvements in devices or apparatus for gripping cables." J. Y. JOHNSON. (Communicated by G. F. ELLIOTT, United States.) Dated May 24th. (*Complete.*)

9,815. "Foot supports for telegraph poles." E. A. STREETER. Dated May 24th. [Date applied for under Patents' Act, 1883, Sec. 103, December 7th, 1891, being date of application in United States.] (*Complete.*)

9,816. "Improvement in motor systems for car propulsion." G. MACAULEY-CRUIKSHANK. (Communicated by the Patton Motor Company, United States). Dated May 24th. (*Complete.*)

9,841. "An improved alloy of aluminium." W. A. BRIGGS. Dated May 24th.

9,850. "Improvements in fans operated by electricity." J. H. PICKUP, J BYROM and J. ASHWORTH. Dated May 24th.

9,863. "Improvements in electric signalling apparatus." H. H. LAKE. (Communicated by the Electric Secret Service Company, United States.) Dated May 24th. (*Complete.*)

9,883. "Improvements in commutator brushes for dynamos or electric motors." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated May 24th. (*Complete.*)

9,891. "Improvements in electrolytic electro-meters." A. G. MCKENNA and H. T. WEED. Dated May 24th. (*Complete.*)

9,895. "An improved safety attachment for overhead electric wires." W. W. HORN. (Communicated by C. D. Brown, United States.) Dated May 24th.

9,906. "Improvements in electrical switches, ceiling roses, fuses, and the like, and in the method of attaching the terminals thereof to the conductors." A. V. PITTAR and E. W. BECKINGSALE. Dated May 26th.

9,910. "Improvements in the method of and apparatus for electrifying air, gas, or vapour for various useful purposes." C. P. SHREWSBURY and J. L. DOBELL. Dated May 26th.

9,932. "Improvements in electric meters." P. E. SINGER. Dated May 26th.

9,933. "The electro plating brush." C. J. JONES. Dated May 26th.

9,941. "Improvements in electrical contacts." C. H. SMEETON and H. PAGE. Dated May 26th.

9,947. "Apparatus for use in insulating joints in insulated electric conducting wires." R. HADDAN. (Communicated by A. Grammont, France.) Dated May 26th. (*Complete.*)

9,959. "Improvements in the construction of apparatus for electric search lights and signalling purposes." T. COAD. Dated May 26th.

9,983. "Improvements in the method of and apparatus for propelling vehicles upon railways by electricity." W. P. THOMPSON. (Communicated by E. E. Ries and A. H. Henderson, United States.) Dated May 26th. (*Complete.*)

10,014. "Improvements in incandescent electric lamps." J. MELHARDT. Dated May 26th.

10,022. "Improvements in electro-telephonic apparatus." C. J. GRIST. Dated May 26th.

10,059. "Improvements connected with tubular electric conductors." E. PAYNE. Dated May 27th.

10,060. "Electric meter for recording varying quantities of electrical currents passing in equal time periods over or along a conducting wire. G. W. HART. Dated May 27th.

10,131. "Improvements in telephones." SIEMENS BROS. & Co., LIMITED, and F. JACOB. Dated May 27th.

10,133. "Improvements in insulating attachments for the support of overhead electrical conductors." M. N. BRANDAO. Dated May 27th. (*Complete.*)

10,139. "An improvement in telephonic appliances." R. LOWENSTEIN. (Communicated by C. E. Weiss, Germany.) Dated May 27th.

10,143. "Improvements in dynamo-electric machines and motors." F. H. VARLEY and A. VARLEY. Dated May 27th.

10,145. "An improved differential arc lamp." R. HOLSTEN. Dated May 27th. (*Complete.*)

10,161. "Improved means of telegraphic communication with lightships." S. EVERSHED. Dated May 28th.

10,173. "An improved form of armour for the protection of submarine cables." W. S. SEATON. Dated May 28th.

10,189. "Improvements in electric motors and dynamos." H. CHITTY. Dated May 28th.

10,197. "Improvements in electric furnaces and in the treatment of auriferous sulphides and similar refractory ores by means of the same." J. W. CANN and R. E. COMMANS. Dated May 28th.

10,200. "Improved process and apparatus for the electro-chemical production of bleaching agents." C. KELLNER. Dated May 28th.

10,209. "A new or improved magneto orthopedic appliance." G. EDWARDS. Dated May 28th. (*Complete.*)

10,265. "Improvements in electrical measuring instruments." W. E. AYRTON and T. MATHER. Dated May 30th.

10,270. "Improvements in automatic electric lighting and in the apparatus therefor." E. L. BERRY and F. HARRISON. Dated May 30th.

10,274. "Improvements in distribution of electricity from a central station." A. SWEET. Dated May 30th.

10,303. "Improvements in electrical reciprocating tools." W. P. CARSTARPHEN, jun. Dated May 31st. (*Complete.*)

10,308. "Improvements in tanks or vessels and apparatus used in the purification of sewage and other foul waters by precipitation, and in the treatment of the sludge obtained in such process." H. LOCKWOOD. Dated May 31st.

10,334. "Improvements in dynamo-electric generators and motors." R. KENNEDY. Dated May 31st.

10,367. "Improvements in connections and terminals for electric and other wires and cables." H. SANCHE. Dated May 31st. (*Complete.*)

10,388. "Improvements in secondary batteries." E. FREUND and L. BRISTOL. Dated May 31st.

10,430. "An improvement in electrical insulating sheet." R. WOOD. (Communicated by C. W. Jefferson and R. R. St. John.) Dated June 1st.

10,451. "An automatic switch for electric current transformers." R. N. LUCAS, A. J. MAYNE, and A. G. NEW. Dated June 1st.

10,456. "Improvements in the manufacture of conducting wires for electricity." H. H. LAKE. (Communicated by Madame V. Hannetelle, *née* H. Chapius, France). Dated June 1st.

10,466. "An improved telephone combination." Sir C. S. FORBES, Bart., Dated June 1st.

10,472. "Improvements in apparatus for electrical and magnetic measurements." J. A. EWING. Dated June 2nd.

10,477. "An improved cut-off for electrical purposes." W. W. HORN. (Communicated by J. P. Wooley, Canada.) Dated June 2nd.

10,478. "Improvements in electric generators." W. GRIERSON. Dated June 2nd.

10,484. "An improved method of regulation of the potential difference of electrical conductors." J. SAYERS. Dated June 2nd.

10,497. "An improved alloy of aluminium for use in cycle manufacture." W. A. BRIGGS. Dated June 2nd.

10,520. "Improvements in and connected with electric batteries." A. V. BOECKXSEL. Dated June 2nd.

10,524. "Electrical insulating sheet." A. H. S. DYER. Dated June 2nd.

10,544. "The extra rapid telegraphic apparatus with inverted currents." G. SACCO. Dated June 3rd.

10,602. "Improvements in telephones." A. MYALL. (Communicated by W. S. Harrison, China.) Dated June 3rd.

10,608. "Improvements in electrical accumulators." B. M. DRAKE, J. M. GORHAM, W. C. JOHNSON, and S. E. PHILLIPS. Dated June 3rd.

10,609. "The protection of insulating material or cable, line and like electric wires to preserve the insulating material from atmospheric and other destructive media, and for preventing escape of sound vibrations from telephone wires." W. S. SIMPSON. Dated June 3rd.

10,622. "Improvements in electric switches." C. T. B. BRAIN. Dated June 4th.

10,651. "An improvement in ceiling roses (or fittings) for use with pendant electric light fittings." H. T. SULLY. Dated June 4th.

10,683. "Apparatus for automatic calculation of electric, gas, or water distribution." H. HELBERGER. Dated June 4th.

10,690. "Improvements in anodes for use in electric cells for treating chlorides, fluorides, or other compounds and the like." T. PARKER and A. E. ROBINSON. Dated June 4th.

10,696. "An improved detector cover for electric push-knobs and the like." A. SHIELS. Dated June 4th.

10,706. "Improvements in effecting electric telegraphic communication, applicable especially for telegraphing to lighthouses, either floating or on rocks, at a distance from the shore, or for telegraphing to and from vessels." W. S. SMITH and W. P. GRANVILLE. Dated June 4th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

12,960. "Improvements in electric transformers." W. M. MORDEY. Dated July 30th. Has for its object to construct transformers with a greater economy of material and so that they shall be simple and easy to build, or to take to pieces, shall have a high degree of insulation and efficiency, and shall possess good self-regulating qualities. 2 claims.

13,171. "An improved socket for incandescent electric lamps." J. CRIGGAL, J. BERKLEY, and C. F. WILLIAMSON. Dated August 4th. —Consists of an incandescent electric lamp provided with a base of suitable non-conducting material, said base having a screw-threaded shank and metallic eyes at the opposite points of said shank in combination with a socket formed of spiral retaining wires that engage the threaded shank and the eyes of the same so as to firmly interlock therewith and transmit the current to the filament in the lamp. 3 claims.

14,234. "Improvements in and relating to electric railways." M. CATTORI. Dated August 22nd. Comprises the employment of a constant intensity of electric current, whatever may be the number of electric vehicles or trains in the circuit; in consequence of which the greatest economy in the installation and in working expenses is realised, and the greatest simplicity and safety in the operation of the apparatus is obtained. 7 claims.

14,322. "Improvements in portable electric light holders." W. W. SAVAGE. Dated August 25th. Consists, essentially, of a forked lever, the inner end of which is pivoted on the base plate of the switch, the said lever being connected to a bell crank, the upper end of which is held from connection with the contact plate, which completes the circuit by the weight of the lamp held in the forked end of the lever, upon the removal of which lamp, however, a spring arranged for the purpose forces the upper end of the bell crank into contact with the plate, which completes the circuit.

14,786. "Improvements in electrical combs." J. M. RILEY. Dated September 1st. The objects are to render the comb convenient for use by reducing the bulk of the battery receptacle to proper proportions, and to facilitate and reduce the cost of construction.

CORRESPONDENCE.

A Growing Grievance.

May I once again encroach on your valuable space to air what I consider to be a great grievance, I refer to the growing use, or I should say misuse, of the titles "Electrical Engineer," and "Electrician," by men who have not the faintest shadow of a claim to such.

It seems that all the qualification required now-a-days to use the above titles, is to wear an electropathic belt, or, to put up an electric bell. The number of wiremen, wiremen's labourers, dynamo attendants, lamp trimmers, &c., who call themselves electric engineers is legion.

In all our towns where there is a public supply of electricity, we find ironmongers, gas fitters, plumbers, &c., developing, with the rapidity of the lightning discharge, into electrical engineers, and the amount of harm these latter, or the great majority of them, do to the profession by their inexperience, or ignorance, is incalculable.

Would it not be possible for the Board of Trade, the Institute of Electrical Engineers, or some other body, to grant certificates to competent men? I refer chiefly to wiring contractors; this would at any rate be a guarantee to consumers of electricity that they were placing their work in the hands of men who were competent to carry it out successfully.

I have all along thought that a distinction should be drawn between electricians and electrical engineers, and if such distinction were drawn, I fear the former would be more numerous than the latter, and it is the latter who are wanted chiefly in electrical work of the present day; it would also be an advantage if members of the profession would designate themselves according to the branch they follow, as, for instance, "Electric Light Engineer," "Electric Power Engineer," &c. Further, I think if members and associates of the Institute of Electrical Engineers of England and America would place the letters or abbreviations after their names it would be a guarantee that they were what they professed to be. To instance, that the state of things referred to is not mere imagination, I had two gentlemen (?) calling on me this week, the first had the letters "F.S.L.S.A.," after his name; he styled himself as "Electrician and Engineer," his business was to try and sell me a badly made electric bell at double its value, and, from his conversation, I had no difficulty in ascertaining that he was neither the one nor the other. The second was an "Electrical Engineer," he was not a "Fellow of the Soc. Letters, Science and Arts"; he wished to dispose of an electric belt; perhaps if he sees this he will in future call himself "Electric Belt Engineer," for which title I think he is quite sufficiently qualified, as he informed me the said belt would make a deflection of 50° on a scale, but he did not know if the scale belonged to an ampère, volt or ohm meter.

L. M. Waterhouse, A.Inst.E.E., (Eng. & Amer.).

June 8th, 1892.

Dynamo and Motor Design.

Referring to your recent publication on "Dynamo and Motor Design," may I be allowed to ask Mr. A. T. Snell whether "number of turns on surface of armature" means number of conductors on periphery, or number of complete turns of conductor, on the armature?

Also, taking the case of two armatures, one of the ring type, and the other of the drum. Will not considerable allowance have to be made for the less active portions of conductor on the ring armature? Or does the chart refer to the ring type only? If Mr. Snell will kindly enlighten me on these points I shall feel much indebted.

A. H. Gibson.

June 9th, 1892.

Notes on the Light of the Electric Arc.

I am very much obliged to Mr. Patterson for calling my attention to an error in my recent paper. His first method of finding mean spherical candle-power is complicated enough, but his second one is even more puzzling. It appears to be an erroneous form of Rousseau's method, given originally in *Comptes Rendus des Essais Photométriques à l'Exposition d'Anvers*, in 1885, described in full in *Palaz Traité de Photométrie Industrielle*, p. 16, and in Eric Gerard's *Leçons sur l'Electricité*, Vol. 2, p. 298. This was alluded to in my paper, and was described by Dr. Fleming in the discussion.

There must be some mistake in your correspondent's version, since the mean value of $\cos\theta$ is not $\frac{\pi}{4}$ but $\frac{2}{\pi}$, as "will be easily seen," to use Mr. Patterson's words, from the following ornamental expression, for which I am indebted to a mathematical friend,

$$\frac{1}{\pi}\int_{-\frac{\pi}{2}}^{+\frac{\pi}{2}} \cos\theta\, d\theta = \frac{1}{\pi}\left[\sin\theta\right]_{-\frac{\pi}{2}}^{+\frac{\pi}{2}} = \frac{2}{\pi}.$$

I never could see much use in "mean spherical candle-power," and, in my paper, I observed that "we not only learn nothing fresh, but are likely to be misled, for a light giving the same mean spherical candle-power would not be nearly so useful as an arc." If the determination of mean spherical candle-power needs such an alarming display of mathematics it is really quite time that the idea was dropped, for it is a useless game and not worth the candle.

Alex. P. Trotter.

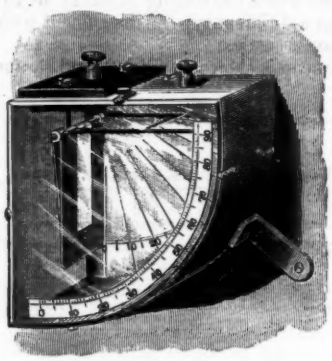
June 15th, 1892.

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

Lord Kelvin's Instruments.

Improved Gold-Leaf Electroscope for the Approximate Measurement of Potentials above 500 Volts.

THIS instrument is an improvement upon the well-known electroscope in which a pair of gold leaves, pith balls, or other light bodies are used for showing by their mutual repulsion some of the elementary phenomena of electrification.



GOLD LEAF ELECTROSCOPE.

The object of the invention is to provide a convenient means of measuring approximately differences of potentials in cases where the accuracy of an electrometer is not required, and where its consequent expense would be a serious consideration. In the instrument to be described only one narrow gold leaf is used, and this is attached by a clamp to a broad plate of brass. This brass plate is supported on a block of vulcanite from the roof of the case, and has a binding screw attached to it. The case of the instrument—with the exception of the front, which is of glass—is of metal, and the portion below the leaf is cylindrical in shape so as to obtain from its inductive action a wide range of sensibility. A scale is engraved upon the back of the case, and another is placed in front close to the glass, in order that the deflections of the instrument may be read off without error due to parallax. A hinged frame is attached to the repelling plate, which folds down over the leaf to prevent damage during carriage, and when turned up as shown in the figure it acts by repulsion as a guard which effectually prevents the leaf from touching the roof of the case at abnormally high potentials. Two terminals are provided: one attached to the case, and the other on the vulcanite block is in metallic connection with the repelling plate and the gold leaf.

This instrument, as above stated, is intended mainly as an approximate potential indicator for high potential circuits, and it may be used with advantage as a constant indicator to test the equality of the pressures between earth and each of the two primaries of a high tension system. It is also useful to test that the potential of the secondary or distributing circuit is less than 200 volts. As a lecture room instrument it will be found more convenient and less liable to damage than the ordinary forms of electroscopes hitherto employed.

Sir William Thomson's Electric Watt Balance for the Measurement of Current up to 10,000 Ampères.

These instruments were designed, in the first instance, to meet requirements for a standard balance to read up to 10,000 ampères. For this purpose it was not considered advisable to use the ordinary *idiostatic* "Thomson" balance, on account of the necessarily enormous proportions which the movable beam would have, and the consequent limitation of range due to possible stiffness in the suspending ligament. The instrument (fig. 1) was therefore designed on the plan of the Thomson composite balance, in which the main current passes through heavy copper conductors, while a small current of measured amount is passed through two coils of fine wire at each end of a movable beam, in every way similar to that

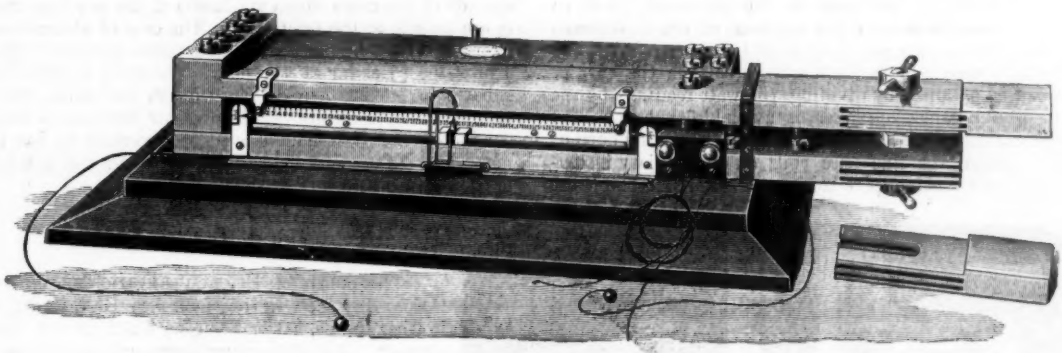


FIG. 1.—10,000 AMPERE BALANCE.

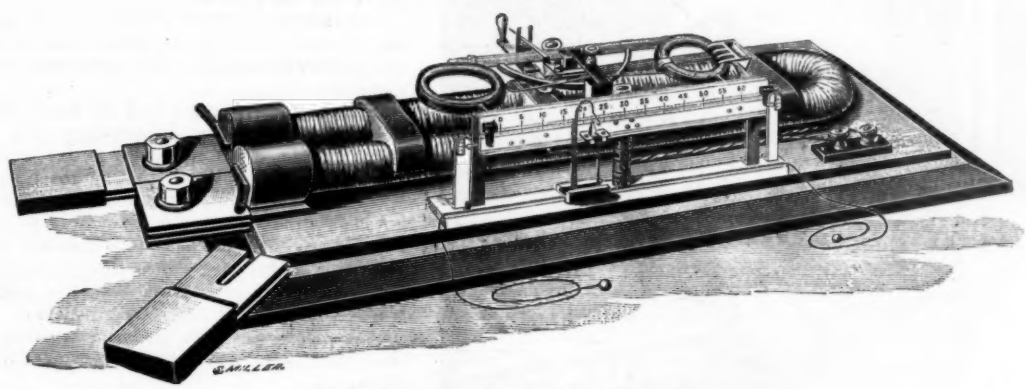


FIG. 3.—ALTERNATE CURRENT KILOWATTMETER.

of the "Thomson" centi-ampère balance. The main conductor is shaped like a double rectangle, as shown in fig. 2, and the current is conducted in by one electrode round three sides of the top rectangle, then down by a connecting piece at a round three sides of the bottom rectangle, and out by

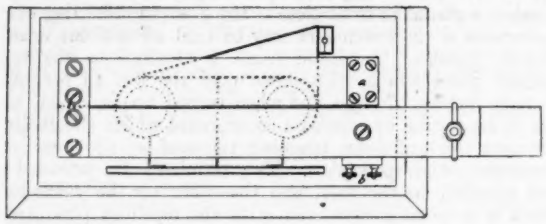


FIG. 2.

the other electrode. The beam, with its movable fine wire coils, is situated between the two rectangles, and its terminals are brought to two binding screws shown at *b*. The action, when the current is passing, is the same as in the other "Thomson" electric balances, viz., the right hand coil on the beam is attracted and repelled up by the current passing through the fixed conductors above and below, and the left hand coil is similarly repelled and attracted down, the resulting force being balanced by the sliding along of a weight on a graduated scale. The conducting rectangles are each made of a thick copper plate, with a slot about 0·5 cm. wide, cut from the right hand side up to within 9 cm. of the left hand end.

The instrument is, of course, a self-contained wattmeter, and when it is to be used as such, extra resistances are provided for the fine wire circuit. The resistance of the fine wire coils is about 10 ohms, and the extra resistances provided are sub-divided into coils of 400 ohms each, so as to permit of an adjustment of the constant of the instrument from 50 to 2,000 watts per division of the scale. When the instrument is used as a standard ampère balance the current values can be obtained by dividing the watt readings by the E.M.F. if a reliable voltmeter is available, but for very accurate working it is best to measure the actual current passing through the fine wire coils on an auxiliary instrument, such as a centi-ampère balance. By this method great sensibility can be obtained, as currents up to 1 ampère can be used, and so the constant of the instrument can be varied at pleasure from 0·1 ampère to 10 or 20 ampères per division of the scale; and thus a range of measurement from 0·1 to 12,000 ampères is provided. The balance, as described, is intended for use with a continuous current, and it is evident that an instrument of this kind, if used with an alternating current, would require a special constant to suit different periods of alternation.

Alternate Current Kilowatt-Meter.

To suit cases where the testing is either on direct or alternating systems a different type of instrument with a stranded main conductor is made.

The instrument is shown in figs. 3 and 4, and it will be

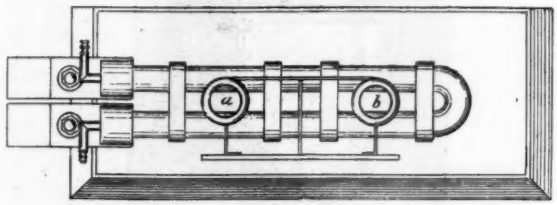
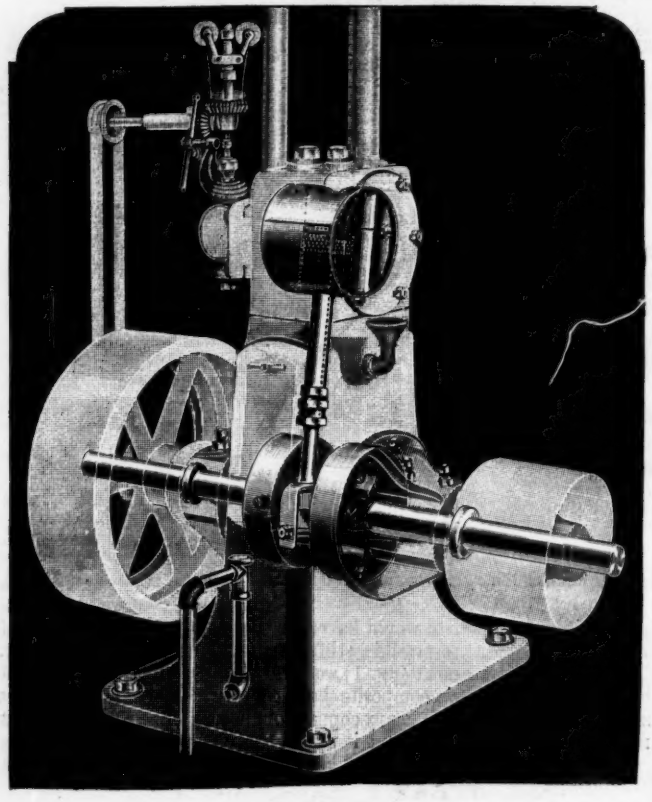


FIG. 4.

seen that the main conductor is of U-shape, and passes under the movable coils. This conductor is made up of ropes of insulated copper wire, twisted together so as to form a cable with a hollow core. In order to correct any effect due to the induction of one arm of the coil upon the other, the twisting is done in a very careful manner, so that the strands of the cable which are inside at the position marked *a*, are outside at the position *b*. The core of the cable is, as mentioned above, hollow, and brass tubes are passed up each arm of the U as far as the bend. The main object of these tubes is to prevent any deformation in the cable, but they also serve as a means of blowing air through to keep the conductor cool, if it should ever be necessary to use it for much heavier currents than those for which the instrument is primarily intended.



CASE ENGINE.

The J. T. Case Engine.

The South of England Electric Manufacturing Company show in the Machinery Hall, among many other things, a small engine which is not without merit. The distinctive feature of this engine is its simplicity. The only moving pieces are the cylinder, piston and crank shaft.

The extreme lightness of these moving parts and their direct action on the crank make it possible and practicable to attain high speed with very little vibration.

For running dynamos and in other situations where close regulation is necessary, and a high degree of economy is looked for in the performance of the engine, an automatic cut-off governor is substituted for the ordinary throttled regulator. This governor differs from the common type of shaft cut-off governors, inasmuch as it does not diminish the throw of the valve and so throttle the steam on light loads, but has always the same amount of travel, the regulation being effected by its rotating the eccentric on the shaft and thus giving the valve the right amount of lead over the crank.

The cut-off valve is of the plug type, perfectly balanced, and made with a slight taper so that it can always be kept tight. Its only duty is to define the point of cut-off; the admission, release, and compression being controlled by the rocking of the cylinder which forms a valve action.

The engine lubricates by running in water and oil, the crank pin and boxes are splashing into it at every revolution, and the bearings are supplied by diverting to them a stream of oil which follows the crank disc around.